
**Geotechnical Investigation into
the Stability of Slopes
in OU 5, Rocky Flats Plant**

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GEOTECHNICAL INVESTIGATIONS INTO THE STABILITY OF SLOPES IN OU 5, ROCKY FLATS PLANT

ABSTRACT

A geological and geotechnical investigation of the "Old Landfill," located in Operable Unit (OU) 5, Woman Creek Priority Drainage, was conducted during the winter of 1994-1995 to evaluate historical and recent landslides in the area. The purpose of this investigation was to provide soil and rock data for design of an in-situ stabilization and capping alternative for the OU 5 Feasibility Study (FS).

The Old Landfill is located on the south central portion of the industrial area on the edge of the Rocky Flats Alluvium pediment surface. Local surficial deposits consist of Rocky Flats Alluvium, waste, fill materials, colluvium, and alluvium. Arapaho Formation claystones underlie the surficial deposits. Numerous groundwater seeps and springs occur at the contact between the Rocky Flats Alluvium and the underlying claystone bedrock subcrop. The development of mass-wasting along the edge of the Rocky Flats Alluvium pediment surface appears to be enhanced by the presence of these springs. Historical and recent aerial photographs show the presence of at least five mass-wasting, slump features with well-defined head and lateral scarps.

Investigative methods included review and comparison of historical and recent aerial photographs and the collection of California-modified split-spoon, Moss sampler, and Shelby-tube samples from hollow-stem auger boreholes. Twenty boreholes were sited on the basis of the aerial photograph review, geologic mapping, and site findings.

A geotechnical laboratory report from Advanced Terra Testing contains selected data from samples including: Atterberg limits results, specific gravity tests, unconfined compressive strength tests, moisture content analysis, moisture and density analysis, modified Proctor compaction tests, hydrometer analysis and mechanical grain size analysis, -200 sieve-grain size analysis, triaxial shear tests TX/CUpp, consolidation tests, and direct shear tests. These data are used to define strength parameters for the materials sampled.

Results of the investigation indicate that 9 of the 20 boreholes intersected mass-wasting detachment planes. Shelby Tube samples were collected across the failure plane in 2 of the 9 boreholes. Conceptual and computer models were constructed to determine whether a predictive model could be generated with UTEXAS modeling software. The results from this study are preliminary; however, problems encountered in modeling the moderate to weathered, sheared Arapaho Formation confirm the detachment planes observed in the boreholes.

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1. INTRODUCTION

1.1 REGIONAL GEOLOGIC AND SEISMIC HISTORY

The Rocky Flats Environmental Technology Site (RFETS) is situated on the western margin of the Colorado Piedmont, an old erosional surface bounded by the eastern front of the Rocky Mountains to the west and the High Plains section of the Great Plains to the east. The Piedmont slopes eastward and is incised by drainages flowing from the Front Range into the Great Plains. The Rocky Flats pediment was formed by erosion of Cretaceous (Laramie and Arapaho) bedrock formations, and subsequent deposition of the Pleistocene Rocky Flats Alluvium atop the resulting eroded surface. Rocky Flats Alluvium consists of alluvial fan deposits derived from the Front Range.

The claystone bedrock slopes beneath the Rocky Flats Alluvium were exposed by continued stream erosion through the pediment. Mass Wasting on these slopes probably commenced at about the middle Pleistocene, shortly after the slopes were initially exposed (Shroba and Carrara, 1994). A more detailed description of the geologic history and setting of the RFETS region is presented in the *Sitewide Geologic Characterization Study* (EG&G, 1995).

Historic seismicity in the RFETS region is dominated by the swarms of earthquakes triggered by injection of wastewater into a deep disposal well at the Rocky Mountain Arsenal (just north of Denver and about 18 miles east of RFETS). This swarm occurred mostly between 1962 and 1967 and included earthquakes of up to magnitude 5.3. The largest of these earthquakes occurred over a year after injection was terminated. The earthquake hypocenters defined a previously unrecognized right-lateral strike-slip fault or fracture zone about 16 km in length (referred to as the Rocky Mountain Arsenal fault in Kirkham and Rogers, 1981). Studies of these earthquakes have suggested that natural tectonic stresses are present in this area and that the earthquakes would have occurred eventually without being triggered by fluid injection (Kirkham and Rogers, 1981).

Prior to these events, the largest historic earthquake in the Front Range area occurred in 1882. This event was felt in the Denver area with a Modified Mercalli intensity VII. Different studies place the epicenter very roughly at locations ranging from 20 miles north to 60 miles northwest of Denver with estimated magnitudes ranging from 6.2 +/- 0.3 (Kirkham and Rogers, 1986) to 6.5. These studies include a magnitude 4.3 earthquake in 1981, just northeast of Denver, and a magnitude 4.0 earthquake on Christmas Day in 1994 about 30 miles south of Denver.

Several faults showing Quaternary displacement have been identified in the Front Range. These faults include the Golden fault, a northwest-trending, steeply west-dipping reverse fault thought to be at least 20 miles long. The northernmost extent of this fault is located approximately 4 miles west of the OU 5 study area at RFETS. The fault shows evidence of movement sometime between 700,000 and 125,000 years ago (Kirkham and Rogers, 1981). Despite their low frequency of historical earthquakes, many of the Front Range faults have extensive histories of recurrent movement, some of which date to Precambrian time. The large total displacements that occurred on some of these faults in Miocene-Pliocene time, and the relatively short geologic time since last

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movement compared to their total period of activity, suggest that future Holocene movements on these faults are probable (Hansen and Crosby, 1982). A map entitled "Potentially Active Faulting in Project Region" is shown in Figure 3.

Kirkham and Rogers (1981) estimated a Maximum Credible Earthquake (MCE) for the Eastern Mountain (Front Range) seismotectonic province of Colorado to be within a range of a magnitude of 6 to 6.75. A magnitude 6.6 earthquake on the Golden fault at a distance of 4 miles from the OU 5 area would produce a peak horizontal rock acceleration of about 0.5 g at the site (estimated from Seed and Idriss, 1983).

1.2 HISTORIC AND RECENT MASS-WASTING EVENTS AT OU 5

Most of the slopes along drainages in the Rocky Flats region are characterized by a very high incidence of mass wasting compared to the surrounding area. This concentration of sliding is related to the presence of weak claystone formations that underlie the majority of these slopes. Many of the slides in the RFETS area probably have thicknesses ranging from 3 to 10 meters. Although Shroba and Carritra reported (1994) slides as much as 30 meters thick.

As evidenced by large landslides in a 1937 pre-Rocky Flats Plant aerial photo, portions of the pre-landfill slopes were unstable at the time of fill placement. Waste materials related to production activities at the Rocky Flats Plant were dumped onto the slopes above Woman Creek in the general area below Buildings 440 and 460. These areas of fill were collectively described as the "Old Landfill." The waste was mixed with native soils and presumably placed directly onto the unprepared, natural slopes.

Various episodes of mass wasting have occurred within and adjacent to the landfill, undermining the stability of the fill and underlying materials. Potentially harmful chemical wastes are exposed during these mass-wasting events. The primary directive of this study is to determine the stability of slopes within the Old Landfill site. Secondary directives include the recommendation of design strategies for the stabilization of all potentially unstable slopes. To accomplish this study, the geologic (i.e., soils, stratigraphy, and hydrogeology) and geotechnical investigation of the landfill focused on historic information, field investigations, and laboratory data.

1.3 GEOTECHNICAL DATA

Geotechnical investigations by the Department of Energy, EG&G Rocky Flats, and Rust Environmental into the slope stability of materials within and near the "Old Landfill" in OU 5 include information from the log book entries made during drilling operations (Appendix 1), surface mapping (Appendix 2), and geotechnical laboratory data. The log book contains: the number of blow counts required to drive the sampler 2'; a complete description of the geology of samples taken from a split-spoon, Shelby Tube sampler apparatus; samples designated for specific laboratory analysis as well as the purpose for analysis; and anomalies encountered during the drilling event. The surface field map is an integration of aerial photographic observations and interpretations and surface mapping data compiled on a 2-foot contour topographic map. This map includes geological, biological, and

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anthropogenic information for the purposes of a complete slope stability analysis. Geotechnical laboratory data from Advanced Terra Testing contains selected data from samples including: Atterberg limits results (ASTM D 4318), specific gravity tests (ASTM D 854), unconfined compressive strength tests (ASTM D 2166), moisture content analysis (ASTM D 2216), moisture and density analysis (ASTM D 2216 and D 2937), modified Proctor compaction tests (ASTM D 1557), hydrometer analysis and mechanical grain size analysis (ASTM D 422), -200 sieve-grain size analysis (ASTM D 1140), triaxial shear tests TX/CUpp (ASTM D 4767), consolidation tests (ASTM D 2435), and direct shear tests (ASTM D 3080).

The author's analysis of the laboratory data is included in Appendix 3. Included are data tables for all tests, Mohr Circle Diagrams constructed from cohesion c and angle of internal friction (ϕ) values from Triaxial Shear Tests, and unconfined compressive strength tests.

The Preliminary Geologic Map is refined from the field compilation map by Rust Environmental and is presented as a fold-out map in pocket 1. Colored geologic cross-sections A-A', B-B', C-C', D-D', E-E', and F-F' (see Figures 2, 3, 4, 5, 6, and 7) are a compilation of geologic and geotechnical information from boreholes along each line (Appendix 4). Cross-section A-A' is followed by information from boreholes 59594, 59694, and 58994. Cross-section B-B' is followed by information from boreholes 59794, 71194, 59294, and 59094. Cross-section C-C' is followed by information from boreholes 56994, 57194, and 57094. Cross-section D-D' is followed by information from boreholes 56894 and 57494. Cross-section E-E' is followed by information from boreholes 56794 and 57694. Cross section F-F' is followed by information from borehole 71294.

Field log book entries and geotechnical laboratory data on individual boreholes are compiled on millimeter paper followed by the borehole data base. This compilation includes the selected sample intervals (hatched) for laboratory analysis, the laboratory analytical data, and pertinent data from the field log book.

Conceptual slope-stability models of the Old Landfill site are constructed from cross-sections provided by Rust Environmental. These conceptual models are entered into UTEXAS software for correct locations of critical shear surfaces and factor of safety calculations. The model inputs and outputs appear in Appendix 6.

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2. GEOLOGIC AND GEOTECHNICAL EVALUATIONS OF CROSS-SECTIONS A-F

2.1 CROSS-SECTION A-A'

Line A-A' is located on the OU 5 Preliminary Geologic Map (Appendix 2) near the western edge of the Old Landfill which includes the geotechnical boreholes 59594, 59694, and 58994 (Appendix 4). Borehole 59594 is in Rocky Flats Alluvium at the top of the terrace approximately 50' from the edge of the natural terrace located in the 1967 aerial photograph. Borehole 59694 is located in Fill materials 150' from the top of the Old Landfill edge and 30' north of the South Interceptor Ditch (SID). Borehole 58994 is located in the Woman Creek floodplain 130' north of the new creek channel.

The subsurface geology is displayed in the geologic cross-section along A-A' (Appendix 4), which is subdivided into five units. The deepest unit is the Arapaho Formation which grades from fresh to moderately weathered at the upper surface. The Arapaho Formation is unconformably overlain by the Rocky Flats alluvium in the terrace located on the left of cross-section A-A'. The Arapaho Formation is unconformably overlain by the Woman Creek alluvium located on the right of the cross-section A-A'. Slide materials from pre-1937 and 1951 mass-wasting events from the terrace edge occur as colluvium above the Arapaho Formation in the center of the cross-section. These materials are overlain by anthropogenic activities including a road at the top of the terrace, land fill materials dumped on Rocky Flats alluvium and colluvium, and the South Interceptor Ditch (SID) excavated through the toe of the landfill material.

Cross-section A-A' intersects the water table of the landfill site along a thin saturated zone underlain by weathered and fresh Arapaho Formation claystones that confine water movement to the upper surface. From the water moisture data defining the saturated zones, it may be assumed that the water moves below ground surface (bgs) along the upper terrace within the Rocky Flats alluvium toward the Old Landfill and downslope within the fill materials, colluvium, 1937 and 1951 slide materials, and into the Woman Creek alluvium. The groundwater is shallow north of Well 59694.

The angle of repose of the initial shear-surface between the basal Rocky Flats alluvium and the overlying fill materials at the top of the Old Landfill varies between 22° and 15°. The steeper slopes grade downslope along a traverse of 120' into an approximately 5° sloped final shear-surface contact between the older colluvium-slide materials and the moderately weathered Arapaho.

Borehole 59594 contains highly weathered claystones of the Arapaho Formation at the contact between the Arapaho and the colluvium slide materials. Borehole 59694 contains moderately to slightly weathered claystones at the contact. There were no fractures reported in the geotechnical logs.

Geotechnical studies of one 2' soil interval from borehole 59594 include one Atterberg test, one soil-moisture measurement, and three triaxial shear tests on Rocky Flats alluvium. Results of a 40.4 plasticity index and a 56.2% liquid limit indicate a high sensitive clay content and a moderate to high resistance to mass-wasting events on low slopes. The sample contains 18.2% water and is from

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the saturated zone. Results of $c = 2000$ psf, $\phi = 17.5^\circ$ and an average .51 Skempton's pore pressure parameter derived from the triaxial shear test measurements under field pore pressures indicate that at 2000 psf overburden pressure failure occurs for these normally consolidated clay soils.

Geotechnical studies of selected soil samples from borehole 59694 include one Atterberg test in the fill material, three soil-moisture measurements on selected fill samples, one moisture-density on a selected colluvium/slide sample and an unconfined compressive strength test on one fill sample. Results of a 32 plasticity index and 47.1% liquid limits from the Atterberg test indicate a low resistance to mass-wasting events on low slopes. Low-moisture contents of fill materials averaging 12.5% indicate a stable soil/moisture content at this time. A sample from the colluvium/slide material contained 15.7% water at a depth of 14'. Results from an unconfined compressive strength test on one fill sample indicates the maximum load of $c = 1182$ psf and $\phi = 0^\circ$ at which failure would occur in near-surface fill materials.

2.2 CROSS-SECTION B-B'

Line B-B' is located on the OU 5 Preliminary Geologic Map (Appendix 2) in the west-central part of the Old Landfill (the thickest part) which includes the geotechnical boreholes 59794, 71194, 59294 and 59094 (Appendix 4). Borehole 59794 is in fill materials at the base of the terrace approximately 80' from the edge of the 1951 head scarp located at the top edge of the Old Landfill. Borehole 71194 is one of two deep boreholes located in fill materials 5' downslope from borehole 59794. Borehole 59294 is located in the toe of the fill south of the SID and a small access road. Borehole 59094 is located in colluvial materials at the toe of an old slide and adjacent to an old creek channel. Borehole 71194 is drilled deep into the Arapaho Formation to determine whether mass wasting occurred along deep fractures.

The subsurface geology is displayed in the geologic cross-section along B-B' (Appendix 4) which is subdivided into six units. The deepest unit is the Arapaho Formation which grades from fresh to moderately weathered at the upper surface. The Arapaho Formation is unconformably overlain by the Rocky Flats alluvium in the terrace located on the left of cross-section B-B'. The Arapaho Formation is unconformably overlain by the Woman Creek alluvium located on the right of the cross-section B-B'. Slide materials from pre-1937 and 1951 mass-wasting events from the terrace edge occur as colluvium above the Arapaho Formation which grade into the landslide materials. These materials are overlain by anthropogenic activities including a road at the top of the terrace, land fill materials dumped on Rocky Flats alluvium and colluvium, an SID excavated through the toe of the landfill material, and an access road adjacent to the SID.

The cross-section B-B' intersects the water table of the landfill site along a very thin saturated zone underlain by weathered and fresh Arapaho Formation claystones that confine water movement to the upper surface. From the water moisture data defining the saturated zones, it may be assumed that the water moves bgs along the upper terrace within the Rocky Flats alluvium toward the Old Landfill and downslope within the fill materials, 1937 and 1951 slide materials, and into the Woman Creek alluvium.

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The angle of repose of the initial shear-surface between the basal Rocky Flats alluvium and the overlying fill materials at the top of the Old Landfill varies between 25° and 30°. The steeper slopes grade downslope along a traverse of 150' into an approximately 5° final-shear surface contact between the older colluvium-slide materials and the moderately weathered Arapaho Formation.

Borehole 59794 contains highly weathered claystones of the Arapaho Formation at the contact between the Arapaho and the Rocky Flats alluvium materials. Borehole 71194 contains moderately to slightly weathered claystones at the contact between the Arapaho Formation and Rocky Flats alluvium. Borehole 59294 contains highly weathered claystones of the Arapaho Formation at the contact between the Arapaho and the siltstone/slide colluvial materials. Borehole 59094 contains highly to moderately weathered claystones at the contact between the Arapaho Formation and overlying colluvium.

Borehole 59794 contains iron-stained fractured surfaces at 16.5 ft deep near the Arapaho/Rocky Flats alluvium contact and 20'-23' deep in slightly weathered Rocky Flats alluvium. Borehole 71194 contains numerous horizontal fractures in the upper weathered Arapaho at 27' deep near the contact of Rocky Flats alluvium. Additional fractures occur at 33'-35' ft oriented 30°-60° to horizontal, at 37'-38' near vertical and at 43'-43.5' oriented 30°. Borehole 59294 contains fractures at 12'-14', at 15.4' with sharp contact, at 21' along strongly slickensided surfaces, and at 21'-29' with occasional slickensided surfaces. No fractures were reported in borehole 59094.

Geotechnical studies of the 17'-18' depth sample from borehole 59794 include one Atterberg test in the top of the weathered Arapaho Formation and one soil moisture-density measurement. Results of a 33 plasticity index and 55.7% liquid limit from the Atterberg test indicate a low resistance to mass-wasting events on low slopes. This sample contained 19.4% water.

Geotechnical studies of selected soil samples from 2' soil intervals from borehole 71194 include one Atterberg test, one soil moisture-density measurement, and one direct shear test. Results of a 44.7 plasticity index and a 66.8% liquid limit indicate a high sensitive clay content and a moderate to high resistance to mass-wasting events on low slopes. The samples from the weathered Arapaho contains 16.5% and 22.8% water and are from the saturated zone. The peak shear strength and the ultimate shear strength is measured at $c_u = 31.9$ with a shear strength of 1390 lbs./ft.² and $c_u = 26.4$ with a shear strength of 1150 lbs./ft.² respectively, for the upper weathered Arapaho Formation materials in contact with Rocky Flats alluvium.

Geotechnical studies of selected soil samples from borehole 59294 include three Atterberg tests, two -200 sieve analysis measurements, two soil-moisture measurements, two triaxial shear tests, and one direct shear test. Results of 30.4 plasticity index and 48.8% and 52.3% from the Atterberg tests on two soils from slide materials indicate a low resistance to mass-wasting events on low slopes. Results of 51.2 plasticity index and 70.5% liquid limit indicate a high resistance to mass-wasting events on low slopes. The -200 sieve measurements indicate a high 97.1% and 97.6 % clay size in slide materials and weathered Rocky Flats alluvium materials, respectively. These samples contain high moisture contents of 17.5% and 19.7%, respectively, and are part of the saturated zone. Results of $c = 0$ psf, $\phi = 34.5^\circ$ and a 0.41 Skempton's pore pressure parameter are derived from the

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triaxial shear test measurements under field pore pressures for these normally consolidated clay soils. The single point analysis is not useful in determining the angle of internal friction or cohesion of this material. Results of $c = 0$, $\phi = 28.5^\circ$, and $\phi = 30.5^\circ$ are not useful in determining the angle of internal friction or cohesion of this material. However, a plot of all triaxial shear tests on weathered and fractured-weathered Arapaho Formation materials reveals a maximum value of $c = 900$ psf, $\phi = 22^\circ$ can be obtained. The wide range in "best fit lines" indicate a wide variability in characteristics in the rock possibly resulting from the extent of weathering and fracturing in each sample. The peak shear strength and the ultimate shear strength is measured at $c_u = 74.0^\circ$ with a shear strength of 4200 lbs./ft.² and $c_u = 43.5^\circ$ with a shear strength of 1200 lbs./ft.² respectively, for the upper weathered Arapaho Formation materials in contact with Rocky Flats alluvium.

Geotechnical studies of one 2' soil interval from borehole 59094 include one soil-moisture measurement. The sample contains 15.1% water and is part of the unsaturated zone.

2.3 CROSS-SECTION C-C'

Line C-C' is located on the OU 5 Preliminary Geologic Map (Pocket 1) in the east-central part of the Old Landfill which includes the geotechnical boreholes 56994, 57194, and 57094 (Appendix 4). Borehole 56994 is located in fill materials 30' from the top of the terrace on a near 45° angle slope surface. Borehole 57194 is the second deep borehole located in landslide materials 100' downslope from borehole 56994. Borehole 57094 is located in a section of detached fill materials and in the center of the thickest colluvium/landslide materials 2' south of the SID.

The subsurface geology is displayed in the geologic cross-section along C-C' (Appendix 4) which is subdivided into five units. The deepest unit is the Arapaho Formation which grades from fresh to severely weathered at the upper surface. The Arapaho Formation is unconformably overlain by the Rocky Flats alluvium in the terrace located on the left of cross-section C-C'. The Arapaho Formation is unconformably overlain by the Woman Creek alluvium located on the right of the cross-section C-C'. Slide material deposits from pre-1937 and 1951 mass-wasting events near the terrace edge are the result of one large landslide event (1951) and multiple small events (evident in the 1937 aerial photograph) above the Arapaho Formation. The thickness of the slide materials is the most prominent feature in cross-section C-C'. These materials are overlain by anthropogenic activities including a road at the top of the terrace, land fill materials dumped on Rocky Flats alluvium and landslide materials, a SID excavated through the toe of the landfill material, and an access road adjacent to the SID. A detached part of the fill materials indicate that 135' of downslope sliding occurred from the time of fill material emplacement.

The cross-section C-C' intersects the water table of the landfill site along a thin saturated zone underlain by weathered and fresh Arapaho Formation claystones that confine water movement to the upper surface. Based on the water moisture data defining the saturated zones, the assumption may be drawn that the water moves bgs along the upper terrace within the Rocky Flats alluvium toward the Old Landfill and downslope within the fill materials, fill/slide materials, pre-1937 and 1951 slide materials, and into the Woman Creek alluvium.

The angle of repose of the initial shear-surface between the basal Rocky Flats alluvium and the

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overlying fill materials at the top of the Old Landfill varies between 15° and 10°. The gentle slopes grade downslope along a traverse of 180' into an approximately 18° contact between the older colluvium/slide materials and the moderately weathered Arapaho Formation. The slope curves upward at a 3° final shear-surface angle near the toe of the slope and surfaces in the Woman Creek area, 530' from the top of the landfill. This broad scale feature forms a broad arc as displayed in cross-section C-C". A series of similar shaped arcs are present within the slide/colluvium materials.

Borehole 56994 contains fresh claystones of the Arapaho Formation at the contact between the Arapaho and the Rocky Flats alluvium. Borehole 57194 contains severely weathered claystones at the contact between the Arapaho Formation and the wastefill/slide materials. Borehole 57094 contains moderately to slightly weathered claystones at the contact between Arapaho Formation and colluvium/slide materials.

Borehole 56994 contains slickensides on 60° fracture surfaces at a depth of 24.8'. Borehole 57194 contains some 10° angle to horizontal, slickensided-fractures at a depth of 3.2'-4' in wastefill/slide materials. Multiple fracture zones occurs within the Arapaho at the upper weathered surface between 4'-5.3' depth, in weathered claystones with heavily iron-stained joint fractures with vugs filled with gypsum present from 9.2'-10' deep, in fresh claystones in a breccia at 38.5'-39.5' deep, and in fresh claystones at 73.5'-74.5' deep. Borehole 57094 contains some slickensides in fill materials between 8.5'-10.5' depth. A chaotic zone of colluvium/slide materials exist between 22'-34' depth. Tight-multiple fracture surfaces are observed in the upper moderately weathered Arapaho Formation.

Geotechnical studies of selected soil samples from 2' soil intervals from borehole 56994 include four Atterberg tests, three -200 sieve analysis tests, and five soil moisture measurements. Results of nonplastic to 25 on the plasticity index and liquid limits of 35.4% to 43% are reported for wastefill materials. The samples from the wastefill are low in clay content ranging from 4.1-16.4%. Moisture levels are measured at 0.3%-8.4%. Results of a 17.9 plasticity index and 34% liquid limit is much lower than reported for Rocky Flats alluvium in borehole 59594 along line A-A'. This sample contains 28.2% of the clay sized fraction. Water content of Rocky Flats alluvium vary from 12.4-16.9% and constitutes part of the saturated zone.

Geotechnical studies of selected soil samples from 2' soil intervals from borehole 57194 include two Atterberg tests, two -200 sieve analysis tests, and three soil moisture measurements. Results of 31.9 to 40.9 plasticity index and 68.0% and 53.5% liquid limits are reported for Arapaho Formation materials. The samples from the Arapaho Formation contain 97.7% clay measured in two samples. Moisture levels are measured at 21.1%-17.3% and are part of the saturated zone.

Geotechnical studies of selected samples from the adjacent boring 71494 include one triaxial shear test and two direct shear tests. Results of $c = 0$ psf, $\phi = 26.5^\circ$ and a 0.17 Skempton's pore pressure parameter are derived from the triaxial shear test measurements under field pore pressures for these normally consolidated clay soils. The single point analysis is not useful in determining the angle of internal friction or cohesion of this material. This triaxial shear test of weathered Arapaho Formation

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materials is grouped with the analysis reported in cross-section B-B' in the geotechnical analysis of borehole 59294. The peak shear strength and the ultimate shear strength is measured at $c_u = 74.0^\circ$ and 81.0° with shear strengths of 4200 and 4450 lbs./ft.² and $c_u = 47.5^\circ$ and 55.0° with shear strengths of 1200 and 1050 lbs./ft.² respectively for the upper weathered Arapaho Formation materials in contact with waste slide materials.

Geotechnical studies of selected soil samples from borehole 57094 include four Atterberg tests, one -200 sieve analysis measurements, two soil-moisture measurements, and two triaxial shear tests. Results of between 26.6 to 52.1 on the plasticity index and 26.6 to 72.9% from the Atterberg tests on four soils from slide materials indicate a moderate to high resistance to mass-wasting events on low slopes. The -200 sieve measurement indicate a moderately high 60.1% clay size fraction in slide materials. These samples contain high moisture contents of 8.1% and 18.8% and separate the boundary between the unsaturated/saturated zone. Results of $c = 1150$ psf, $\phi = 15^\circ$ and a 0.30 Skempton's pore pressure parameter are derived from the triaxial shear test measurements under field pore pressures for these normally consolidated clay soils of the colluvium/slide materials.

2.4 CROSS-SECTION D-D'

Line D-D' is located on the OU 5 Preliminary Geologic Map (Appendix 2) in the central part of the Old Landfill which includes the geotechnical boreholes 56894 and 57494 (Appendix 4). Borehole 56894 is located in slide/fill materials 5' downslope from the top of a scarp and 130' from the top of the landfill. Borehole 57494 is located in a section of detached fill materials 20' south of the SID.

The subsurface geology is displayed in the geologic cross-section along D-D' (Appendix 4) which is subdivided into six units. The deepest unit is the Arapaho Formation which grades from fresh to severely weathered at the upper surface. The Arapaho Formation is unconformably overlain by the Rocky Flats alluvium in the terrace located on the left of cross-section D-D'. The Arapaho Formation is unconformably overlain by the Woman Creek alluvium located on the right of the cross-section D-D'. Slide material deposits from pre-1937 and 1951 mass-wasting events near the terrace edge are the result of one large landslide event (1951) and multiple small events (evident in the 1937 aerial photograph) above the Arapaho Formation. These materials are overlain by anthropogenic activities including a road at the top of the terrace, land fill materials dumped on Rocky Flats alluvium and landslide materials, an SID excavated through the toe of the landfill material, and an access road adjacent to the SID. A detached part of the fill materials indicate that 130' of downslope sliding occurred from the time of fill material emplacement.

The cross-section D-D' intersects the water table of the landfill site along a very thin saturated zone underlain by weathered and fresh Arapaho Formation claystones that confine water movement to the upper surface. From the water moisture data defining the saturated zones, it may be assumed that the water moves bgs along the upper terrace within the Rocky Flats alluvium toward the "Old Landfill" and downslope within the fill

materials, 1937 and 1951 slide materials, and into the Woman Creek alluvium. The groundwater is

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shallow south of the access road.

The angle of repose of the initial shear-surface between the basal Rocky Flats alluvium and the overlying fill materials at the top of the Old Landfill varies between 10° and 8°. The gentle slopes grade downslope along a traverse of 150' into an approximately 8° contact between the older colluvium-slide materials and the severely weathered Arapaho. The slope curves upward at a 6° near the toe of the slope at the final shear-surface and emerges in the Woman Creek area, 580' from the top of the landfill. This broad scale feature forms a broad arc as displayed in cross-section C-C". A series of similar shaped arcs are present within the slide/colluvium materials.

Borehole 56894 contains severely weathered claystones of the Arapaho Formation at the contact between the Arapaho and the Colluvium. No fractures were reported in the borehole log.

Geotechnical studies of one soil sample from borehole 56894 include one Atterberg test and one triaxial shear test. Results of a 41.8 plasticity index and 63% liquid limit is reported in the laboratory data. The triaxial shear test for weathered Arapaho Formation is reported in cross-section B-B' in the geotechnical analysis of data from borehole 59294.

2.5 CROSS-SECTION E-E'

Line E-E' is located on the OU 5 Preliminary Geologic Map (Appendix 2) in the eastern part of the Old Landfill which includes the geotechnical boreholes 56794 and 57694 (Appendix 4). Borehole 56794 is located in fill materials 120' downslope from the top of the landfill. Borehole 57694 is located in a section of slide materials 170' south of the SID.

The subsurface geology is displayed in the geologic cross-section along E-E' (Appendix 4) which is subdivided into five units. The deepest unit is the Arapaho Formation which grades from fresh to severely weathered at the upper surface. The Arapaho Formation is unconformably overlain by the Rocky Flats alluvium in the terrace located on the left of cross-section E-E'. The Arapaho Formation is unconformably overlain by the Woman Creek alluvium located on the right of the cross-section E-E'. Slide material deposits from pre-1937 and 1951 mass-wasting events near the terrace edge are the result of a large landslide event or multiple small events (evident in the aerial photograph) above the Arapaho Formation. Small landslides have occurred in the body of the colluvium. These materials are overlain by anthropogenic activities including a road at the top of the terrace, land fill materials dumped on Rocky Flats alluvium and landslide materials, an SID excavated through the toe of the landfill material, and an access road adjacent to the SID. A detached part of the fill materials indicate that 85' of downslope sliding occurred from the time of fill material emplacement.

The cross-section E-E' intersects the water table of the landfill site along a very thin saturated zone underlain by weathered and fresh Arapaho Formation claystones that confine water movement to the upper surface. From the water moisture data defining the saturated zones, it may be assumed that the water moves bgs along the upper terrace within the Rocky Flats alluvium toward the Old

SLOPES STABILITY STUDY

Landfill and downslope within the fill materials, road fill, colluvium, 1937 and 1951 slide materials, and into the Woman Creek alluvium. The groundwater is shallow south of the access road.

The angle of repose of the initial shear-surface between the basal Rocky Flats alluvium and the overlying fill materials at the top of the Old Landfill varies between 19° and 21°. The steeper slopes grade downslope along a traverse of 75' into an approximately 15° contact between the older colluvium-slide materials and the severely weathered Arapaho. The slope curves upward at the final shear surface at a 1° angle near the toe of the slope. The upper surface has two distinct slumps, one within the colluvium-slide materials and one within failed moderately weathered Arapaho Formation as is displayed in cross-section D-D'.

Borehole 56794 contains severely weathered claystones of the Arapaho Formation at the contact between the Arapaho and the colluvium. Borehole 57694 contains severely-moderately weathered claystones at the contact between the Arapaho Formation and Arapaho/slide materials. Iron-stained fractures were reported in borehole log 56794 at a depth of 15.5–22 ft in the severely weathered Arapaho Formation. Slickensides are reported at a depth of 10–11.5 and 14–14.5 ft in Arapaho/slide materials. Iron-stained fractures at a 20° angle to horizontal with slickensided surfaces at 14.5 ft depth are reported in the log book.

Geotechnical studies of selected soil samples from 2' soil intervals from borehole 56794 include two Atterberg tests, one 200 sieve analysis tests, four soil moisture measurements, and one triaxial shear test. Results of 43 to 34 on the plasticity index and liquid limits of 58% to 49.9% are reported for colluvium materials. The sample from the colluvium contains 58.6% clay size fraction. Moisture levels are measured at 14.8% to 31.5% which is the highest measured value in this study. Results of $c = 0$ psf, $\phi = 45.5^\circ$ and a 0.22 Skempton's pore pressure parameter are derived from the triaxial shear test measurements under field pore pressures for these normally consolidated clay soils. The single point analysis is not useful in determining the angle of internal friction or cohesion of colluvium materials.

Geotechnical studies of selected soil samples from 2' soil intervals from borehole 57694 include one Atterberg tests, one 200 sieve analysis test, one soil moisture measurement and three triaxial shear tests. Results of a 43.8 plasticity index and 65.6% liquid limit is reported for Arapaho Formation/slide materials. The samples from the Arapaho Formation/slide materials contain 99.5% clay. Moisture levels are measured at 13.1% and 23.6% and are part of the saturated zone. Results of $c = 360$ psf, $\phi = 18^\circ$ and a 0.37 Skempton's pore pressure parameter are derived from the triaxial shear test measurements under field pore pressures for these normally consolidated clay soils of the Arapaho Formation/Slide materials.

2.6 CROSS-SECTION F-F'

Line F-F' is located on the OU 5 Preliminary Geologic Map (Appendix 2) in the far eastern part of the map outside of the Old Landfill which includes the geotechnical borehole 71294 (Appendix 4). Borehole 71294 is located in slide materials 75' upslope from Woman Creek.

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The subsurface geology is displayed in the geologic cross-section along F-F' (Appendix 4) which is subdivided into four units. The deepest unit is the Arapaho Formation which grades from fresh to severely weathered at the upper surface. The Arapaho Formation is unconformably overlain by the Woman Creek alluvium located on the right of the cross-section F-F'. Slide material deposits from mass-wasting events near the terrace edge are the result of a small landslide event (evident in the 1937 aerial photograph) above the Arapaho Formation. The main feature in this cross-section is a small slide in the colluvium. These materials are overlain by anthropogenic activities including an access road at the top of scarp.

The cross-section F-F' intersects the water table of the landfill site along a very thin saturated zone underlain by weathered and fresh Arapaho Formation claystones that confine water movement to the upper surface. From the water moisture data defining the saturated zones, it may be assumed that the water moves bgs along the upper terrace within the Rocky Flats alluvium toward the Old Landfill and downslope within the fill materials, colluvium, 1937 and 1951 slide materials, and into the Woman Creek alluvium. The groundwater is shallow south of the access road.

The angle of repose of the initial shear-surface between the basal severely weathered Arapaho Formation materials and the overlying slide materials near the toe of the Old Landfill varies between 8° and 6°. The gentle slope grades downslope along a traverse of 50 ft into an approximately 6° sloped contact between the colluvium-slide materials and the severely weathered Arapaho. The upper surface has one distinct slump cross-cutting an older slide above the severely weathered Arapaho Formation.

Borehole 71294 contains severely weathered claystones of the Arapaho Formation at the contact between the Arapaho and the colluvium/slide materials. Claystone slickensided surfaces occur at 60° angle to horizontal adjacent to colluvium in colluvium/slide materials. Abundant iron-stained fractures were reported in the borehole log at a depth of 7.2 to 8 ft at the contact in the severely weathered Arapaho Formation. Clay gouge occurs along a 20° angle to horizontal at 7.8'. Occasional polished-slickensided surfaces are found below 10' depth. Intensely fractured Arapaho Formation with some slickensided surfaces found at a depth between 17.5-17.8 ft depth. Some slickensided fractures are found along horizontal fractures at a depth between 24 to 28 ft. Some slickensided surfaces are found at a depth of 33 to 33.5 ft.

Geotechnical studies of selected soil samples from 2' soil intervals from borehole 71294 include two Atterberg tests, six soil moisture measurements, and one triaxial shear test. Results of 43 to 40.7 on the plasticity index and liquid limits of 63.4% to 62.6% are reported for the severely to moderately weathered contact of Arapaho Formation. One moisture analysis containing 7.5% water is reported for one sample from the colluvium slide base. Moisture levels from samples taken from the Arapaho Formation are measured at 7.5% to 19.4%. Results of $c = 0$ psf, $\phi = 55.5^\circ$ and a 0.38 Skempton's pore pressure parameter are derived from the triaxial shear test measurements under field pore pressures for these normally consolidated clay soils. The single point analysis is not useful in determining the angle of internal friction or cohesion of colluvium materials. This triaxial shear test of weathered Arapaho Formation materials is grouped with the analysis reported in cross-section B-B' in the geotechnical analysis of borehole 59294.

SLOPES STABILITY STUDY

3. SLOPE STABILITY AND CRITICAL SHEAR SURFACE MODELS

3.1 UTEXAS 2-D SLOPE STABILITY MODEL

A joint venture task group of the Computer Applications in Geotechnical Engineering (CAGE) and the Geotechnical Aspects of the Computer-Aided Structural Engineering (G-CASE) projects was tasked in 1984 by Headquarters, US Army Corps of Engineers (USACE), to develop a slope stability package "standard" suitable for Corps-wide use. UTEXAS program was adopted in 1986. The basis of the UTEXAS Program employs the mechanics of limit equilibrium procedures in the study of two-dimensional slope-stability analysis. The three force equilibrium procedures include the wedge method described in the Engineering Manual (EM) 1110-2-1902 (Headquarters, Department of the Army 1970) and two procedures that use the method of slices. These force equilibrium procedures use the Corps of Engineers' Modified Swedish side-force assumption of parallel side forces at a user-specific inclination, EM 1110-2-1902 (Headquarters, Department of the Army 1970), or Lowe and Karafiath's side force assumption (1960). The mechanics of Bishop's Simplified Procedure (Bishop, 1955), and Spencer's complete equilibrium Procedure (Spencer 1967) are also employed in UTEXAS. The various cases of slope-loading conditions (i.e., steady seepage, sudden drawdown), characterization of material properties, and internal water-pressure determinations are not covered in this model.

This report contains the calculation of a factor of safety F , and attempts to calculate the critical shear surfaces for geologic materials along the OU 5 northern slope in the Old Landfill site.

The Factor of safety F in this program is defined with respect to shear strength as

$$F = \frac{S}{T}$$

where

s = available shear strength

τ = shear stress required for just-stable, static equilibrium

The shear strength is expressed in terms of the Mohr-Coulomb failure criteria.

3.2 CONCEPTUAL AND SLOPE-STABILITY MODELS OF THE "OLD LANDFILL"

Conceptual models are drawn from cross-sections constructed by Rust Environmental (Appendix 5). Approximate critical shear surfaces and radii of circles are assigned for model recalculation and relocation. Geologic materials are assigned cohesion and angle of internal friction values from the triaxial shear test data.

SLOPES STABILITY STUDY

Although the above conceptual model parameter data are assigned to the input model in the idealization phase of this study, the model did not accept the decrease in internal friction values in the Arapaho Formation. The models (Appendix 6) constructed with UTEXAS software did not complete the iterations phase of the program.

Although UTEXAS software has calibration capabilities for seismic earthquake data, the model would not accept new information beyond the initial input.

SLOPES STABILITY STUDY

4. DISCUSSION AND CONCLUSIONS

Cross-section profiles drawn through the borehole data indicate a correlation between the fractured, weathered Arapaho Formation detachment surfaces along critical shear surfaces. These shear surfaces coincide with thin saturated zone materials above the weathered surface, and support the position that shear occurs at this juncture. Low internal friction values from the Triaxial shear tests on materials in this region indicate that these are failed materials. Therefore, mass wasting is endemic to slopes underlain by claystone bedrock in the RFETS region.

Based on these observations, the assumption may be made that shallow groundwater drains onto the landfill area slopes from the lower Rocky Flats Alluvium, variably saturates the lower portions of surficial deposits (colluvium and fill), and either ponds within depressions in the weathered claystone or drains further downslope along the top of claystone. This shallow groundwater contributes to slope instability. The UTEXAS model indicates that failure occurs within this zone.

Evidence of detached slide materials and rapidly truncated lithologies in the center of the Old Landfill indicate sheared lithologies have been translated downslope. Mass wasting of fill and/or colluvium atop claystone has occurred within the landfill area.

Deeper landslides, with failure surfaces occurring in moderately weathered claystone, have occurred within the OU 5 study area and have also been documented throughout the RFETS region. It appears that moderately weathered claystone should be considered potentially unstable wherever adverse slope conditions occur. Potentially unstable material of the fractured and weathered Arapaho Formation encountered during this investigation locally occurs to depths of up to about 35' below ground surface within the landfill area.

The potential for sliding in the landfill area was increased as a result of RFP activities, which included the placement of loose fill and drainage outfalls on naturally unstable slopes; however, the existing slides and potentially unstable bedrock which characterized the pre-landfill area slopes still dominate the general instability of the study area. Any engineering solution to stabilizing these slopes must address the potential for sliding within the deeper, moderately weathered Arapaho Formation bedrock.

SLOPES STABILITY STUDY

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Appendix 1

Transcriptions of Log Book Entries

GEOTECHNICAL NOTES

General

Boring 57394

Located near Woman Creek south of landfill

Elevation TBD

Advance boring using 3.25" IDHSA

Sampled Using Cal Mod

Total boring depth:

Water 2.0'

Drilling Contractor - Boyles Brothers / Rig - Mobile Drill B-57

12/01/94

Lithologic Description

0-0.5' top soil

0.5-2' sandy gravel, some silt, tr clay

Cal. Mod 7/20/17/10 @ 0-2' recorded 1.1'/2.0' brown, moist, (GM), dense sandy gravel with occasional cobble

Cal. Mod 7/20 @ 2-3' recorded 1.0'/2.0' saturated @ 2', as above (brown dense) (Page 2) sandy gravel, some silt, little clay (GM)

Cal. Mod 18/50-2" @ 3.0'-3.7' recorded 0.5'/0.7' saturated, brown, very dense, sampler refused on cobble

Cal. Mod 45/40/50-5" @ 4.0-5.5' recorded 1.8'/1.5' slough at top of sampler****, sandy silty gravel (GM), little clay, brown, saturated
****note: typically tough drilling from ground surface to 5.5' due to gravel and occasional cobbles. Drilled from approximately 3 pm to 4 pm and stopped for the day.

Summary: With the exception of surficial topsoil, soils consist of silty sandy gravel with little clay (GM) Soils were brown, saturated at 2', and dense to very dense.

12/1/94 MLY

(Page 3) 12/2/94

Continuation of Geotechnical Notes for Boring 57394

Cal Mod 17/23/23/23 @ 5.4'-7.4' recorded 1.0'/2.0' upper 6" of retained sample consisted of upper soils, namely silty sandy gravel. Bottom 6" consisted of a moist silty clay (CL) with some gravel, little sand, brown to grayish-brown (mottled), stiff Cal interface @ 6.9' [residual soil, heavy iron stain, 7-9'] 3" ST @ 7.4-9.9' recorded 1.3'/2.5' pp 2.9 test torque 0.45 Kg/cm² Gray weathered claystone, silty clay (CL), smooth drilling to clean out borehole from 7.4-10.0'.

3" ST @ 10.0'-12.0' recorded 1.9'/2.0' pp 3.7 test torque 0.5 Kg/cm²

(Page 4) ***note generally friable, locally plastic

9'- 18' moderately to highly weathered, soft, iron stained varies from cobbly-ser weathered clay soil (soil like-no structure) to moderately weathered dark gray claystone

Cal Mod 9/14/23/40 @ 12.0-14.0' recorded 2.0'/2.0' estimate interface between ser weathered clay to moderately weathered

claystone @ 11.0

Cal Mod 10/24/30/45 @ 14.0'/16.0' recorded 2.0'/2.0' dark gray moderately weathered claystone; intermittently iron stained Moss sampler (continuous core w/split spoon) 16.0'-18.0' recorded 1.7' mostly dark olive gray hard drilling @ 19', rare iron staining), less weathered (moderately) from 18' to 18.7', thick, moist less stiff (pp 2.75) dark gray @ 18.7', 18.7' to 20' moderate light gray; slightly weathered, friable, soft, shows horizontal lamiations (bedding), dry hard (soil), 20'-21.8' black moist, plastic, no apparent iron staining (slightly weathered?) soft, carbonaceous, stiff-very stiff (variable),

(Page 5) (bag sample) BH00125AS Moss (21'-21.5') 20' to 22' 21.8'-23.0' moderately gray, damp, slightly weathered, friable, soft, apparent rock structure (tight hairline fractures (60-80°) @ approximately 23' with no iron stain on fractures, occasional black charcoal/organic flecks [total depth at 23'])

Rick Harlan 12/2/94

12/2/94 Friday (Page 6)

Rick Harlan on-site @ 7:20 AM

Met with Scott Hollowell

- (1) respirator fit test
- (2) obtained dosimeter, respirator
- (3) had Pre-Er meeting @ ASI trailer

Met Mark Yaskanin at boring 57394, at approximately 9:30 AM. Took over logging for last portion of hole, from 16' to total depth at 23'. relogged 57394 (see following pages 7, 8, 9, and 10). Finished drilling 57394 @ 12:30 PM. Checked hole locations along west creek with Paul Jordan. Left site at 3:35 PM. Returned to Bloomfield.

(Page 7) (Boring 57394)

Location: near Woman Creek, south of landfill toward the east end Mobile B-57 Drill rig Boyles Brothers

Advance hole with 3.25" ID Hollow Stem Augers

Drive sampling with 3" Shelby Tubes

Moss System (pushing 2.4" ID split barrell [Mod. Col.] sampler.

Note: Cal. Mod. used without liners. Samples placed in cardboard core boxes, except for Shelby Tubes and occasional plastic bag samples.

Water first encountered at approximately 2' bags

Drilled 12/1-2/94

TD @ 23.0' .

(Page 8)

Topsoil

0 - 2' Cal Mod.

Alluvium

7/20/17/10

0.5-6.9' SANDY, SILTY GRAVEL (GM): rec. 1.1/2.0

brown; moist; medium dense-dense; 2'-3' Cal. Mod.

fine to coarse gravel, occasional 17/20

cobbles.

rec. 1.0/1.0

wet at 2.0'

yellowish, brown below approx. 3'

3'-3.7' Cal Mod
18/50/2"
refused on cobble
rec. 0.5/0.7
note: generally rough
drilling, 0'-5.5'
4'-5.5' Cal Mod
45/40/50/5"
rec. 1.4'/1.4'

Arapahoe Formation

6.9-9' CLAYSTONE/LEAN CLAY (CL):
mottled yellow brown, gray brown,
moist; stiff-very stiff. "Rock"
properties: severely weathered to
residual soil; plastic; soft.
Includes occasional rounded
coarse sand to fine gravel

12/1-12/2
5.4'-7.4' Cal Mod
17/23/23/23
7.4-9.9' push 3"
Shelby-pp 2.9 tsf
torvane 0.45 Kg/cm²
*measured at approx.
8.7' bottom of tube
rec. 1.3'/2.5'

(Page 9)

9'-18' CLAYSTONE: variably mod.-
dark, olive gray, gray brown;
varies from highly-severely
weathered (soil-like, w/out
apparent structure) to mod.
weathered w/ discernable rock
structure; friable locally
plastic; soft; appears mostly
massive (ie, few apparent joints
or bedding surfaces).
Intermittent orange iron staining.

smooth drilling to
clean out hole,
7.4' to 10'
10'-12' push 3"
Shelby pp=3.7 tsf
tv=0.5 Kg/cm²
rec. 1.9'/2.0'
12'-14' Cal Mod
9/14/23/40
rec. 2.0/2.0
14'-16' Cal Mod
10/24/30/45
rec. 2.0/2.0
16'-18' Moss
(pushing Cal.Mod.)
rec. 1.7-2.0
18'-20' Moss
rec. 1.8/2.0

18'-18.7' CLAYSTONE: mostly dark
olive gray [rare iron stain]; mod.
weathered; friable; soft;
1" thick, very moist, dark olive
gray (CC-CH), very stiff (?-pp=
2.75, but appears softer) at 18.7'
18.7'-20' CLAYSTONE: H.-mod. gray;
slightly weathered; friable; soft.
Shows some horizontal laminations
(spaced approx. .125-.25" bedding)
20'-21.8' CLAYSTONE: black;
slightly weathered; no iron stain;
plastic; soft; carbonaceous;
Soil Properties: Stiff-very Stiff
(varies); moist; highly plastic;
(CH-OH).

20'-22' Moss
rec. 2.0/2.0
Bag sample 21'-
21.5'

(Page 10)

21.8'-23' CLAYSTONE: mod. gray;
slightly weathered; friable; soft;

22'-23' Cal. Mod.
35/65

several tight, hairline fractures refusal at 23'
(60-80°); without iron staining; rec. 1.0-1.0
en 23'; occ. black organic flecks
(charcoal). Soil Prop.: CL-CH,
damp, hard. Terminate hole @ 23'
Grout Backfill via Tremie.

(Page 11) Monday 12/5/94
on-site @ 7:45

H&S person for drilling is out sick, needs to be replaced; augers still need decontamination. Paul Jordan will call me at Broomfield when ready to drill. Left RFP @ 8:00 AM. Return to RFP @ approx. 12:00 PM. Commenced drilling 58994. Drilled to TD @ 18.3'. Left site @ 4:00 PM, after checking central slide boring locations with Paul Jordan.

(Page 12) Boring 58994

Location: Woman Creek, 35' SW of Well 59393 (at top of slope, toward west end of landfill).

Mobile B-57 drill

Boyles Brothers

Advance hole with 3.25" ID Hollow Stem Augers

Cal Mod drive sampling

Push 3" Shelby Tubes

Moss System

****Thin layer water perched on claystone @ 5'

Drilled 12/5/94

TD @ 18.3'

(Page 13) 58994 cont.

0'-0.1' Topsoil: grass roots, silt 0'-2' Cal Mod

ALLUVIUM

6/13/22/35

0.1'-5' SANDY, SILTY GRAVEL (GM)

rec. 0.5/2.0

H.-moderately brown; damp; med.

attempt Cal Mod

dense; fine-coarse grained,

@ 2'; refusal (bounce)

subrounded gravel; occasional

@ 2'; drill out to 2.8'

cobbles to 4"+;

2.8'-3.7' Cal Mod

dense below approx. 2'

24/50/5"; refusal

trace free water @ 5' (perched on

rec. 0.5/0.9

weathered claystone

ARAPAHOE FORMATION

4.3/6.3' Cal Mod

5'-APPROX. 6.5' CLAYSTONE/LEAN

17/9/11/18

CLAY (CL): mottled yellowish brn.

pp=1.75 tsf @ 5.5'

gray; moist-v. moist; stiff "Rock"

rec. 5.5'-2.0

properties: severely weathered

6.3'-8.8' Push Shelby

(residual soil); plastic; soft.

Tube pulled off head

approx. 6.5'-16' CLAYSTONE: motl.

augered past to 9.3'

gray, yellowish brown; mod. to hly.

for rec.; rec. 1.6/2.5

weathered; plastic-friable; soft;

pp=4.0; tv>1.0 Kg/cm²

shows rock structure (iron stained

9.3'-10.8' Cal Mod

joints, bedding-some thinly

13/25/39

laminated). Soil Properties: moist

drill out to 11.1'-12.4'

hard; mod-high plasticity (CL-CH).

Push Shelby read down

Includes some sandy siltstone (ML) laminae (bedding appears hor.)

pressure up to 8000 #'s
pp=4.5 tsf+ [bottom of
tube slightly dented]
tube pulled off; drilled
out to 13.3' to rec.
rec. 1.3/1.3.

(Page 14) 58994 cont.

approx. 6.5-16' CLAYSTONE; mostly
sandy siltstone (ML), v.f. sand,
from approx. 13.5'-14', mostly
lean clay (silty claystone) from
approx. 14'-16'

abrupt weathering change

@ 16'

16'-18.3' CLAYSTONE: gray; sltly
weathered/fresh; friable; soft;
massive? no apparent bedding.

Soil Properties: damp; hard; mod.
plastic (CL).

Terminate hole @ 18.3'

Grout backfill via Tremie.

13.3'-14.1 Cal Mod

29/50/4" refusal

rec. 0.8/0.8

drill out to 14.3'

14.3-16.3' Moss

harder drilling

@ approx. 16'

rec. 2.0/2.0

pp=4.5+

16.3'-18.3' Moss

pp=4.5'+

(Page 15) Tuesday 12/6/94

Arrived at Bloomfield at 8:15 AM; awaiting call from Paul Jordan to
leave for drilling @ RFP. Snowing heavily. Left Bloomfield for
RFP @ 1:45 PM. On-site at 2:15 PM. Commenced drilling 57794 at
2:45 PM. Drilled to 8'; driller left early to obtain equipment for
tomorrow. Left site at 4:45 PM.

(Page 16) Boring 57794

Location: Lower (S) slope below west end of landfill; 30' southwest
of well 61293.

Mobile B-57 drill

Boyles Brothers

Drill w/ 3.25" ID Hollow Stem Augers

Cal Mod Drive Sampling

Push 3" Shelby Tubes

Moss System

Water not encountered

Drilled 12/6-7/94

TD @ 29'

(Page 17) 57794 cont.

0'-0.1' Topsoil; roots, slty clay

COLLUVIUM

0.1'-6.8' SANDYCLAY (CL): dark brn.
moist; firm; f.-crs. sand, some fine
gravel; occasional roots

mod. organic to 0.5'

-mod. brn.; damp; stiff;

below 0.5'

v. stiff; mottled orange (heavy
iron staining) below approx. 2'

occasional cobbles below 5.5'

0'-2' Cal Mod

5/13/14/18

rec. 2.0/2.0

2'-4' Cal Mod

17/22/28/27

rec. 2.0/2.0

bag smpl. 2.0-2.5'

4'-5.8' push Shelby

rec. 1.8/1.8

v. hard push; refusal

@ 5.8' bottom of tube

ARAPAHOE FORMATION

6.8-8' CLAYSTONE/FAT CLAY (CH):
mottled H. Gray, yellowish brn.;
moist; stiff;. "Rock" Properties:
severely weathered;plastic;soft.
approx. 8'-27' CLAYSTONE: mostly
mod. gray, some orange (iron stn.)
mottling;mod. weathered;friable to
plastic;soft;some rounded iron
concretions up to 0.5" ϕ ;massive.
Soil Properties: damp;v.stiff;mod.

badly dented
6'-8' Cal Mod
30/22/14/21
(eased @ approx. 6.8')
rec. 2.0/2.0
8' 12/6/12/7
8'-10.5' Push Shelby
rec. 2.3/2.5*
pp=3.5 tsf @ 10.3'
10.5'-12.5' Cal Mod
15/21/34/60
rec. 2.0/2.0
*steady push up to
2,500 psi

(Page 18) 57794 cont.

approx. 8'-27' CLAYSTONE (cont.)
plastic (CL), locally CH
generally lean clay/ "silty
claystone".
slightly less weathered (still
mod.), friable, displays some
fracturing. Soil Properties: hard
(soil) below approx. 14'.
locally displays subhoriz. bedding
laminations, w/ iron stained
surfaces), some carbonaceous
material (charcoal), rare, thin-
v. thin silty sandstone laminae.

harder, damp to moist below 23'

27'-29' CLAYSTONE: mod. gray;
slightly weathered/fresh;friable;
soft;massive. Soil Properties:
damp;hard;mod. plastic; (CL-
"silty claystone").

Terminate @ 29'; grout backfill via Tremie.

12.5'-15' Push Shelby*
rec. 2.5/2.5
pp=4.5+ @ 15'
*push up to 3,300 #'s
(rig down pressure)
15'-17' Moss
rec. 2.0/2.0
17'-19' Moss
rec. 2.0/2.0
19'-21' Moss
rec. 2.0/2.0
21'-23' Moss
rec. 2.0/2.0
23'-25' Moss
rec. 2.0/2.0
25'-27' Moss
rec. 2.0/2.0
harder drilling below
approx. 23'
27'-29' Moss
rec. 2.0/2.0

(Page 19) Wednesday 12/7/94

On-site at 7:50

Continue drilling 57794

Complete to TD @ 29', @ 10:45 AM

Left site for Broomfield @ 11:40 AM

(Page 20) Thursday 12/08/94

On site @ 7:55 AM. Meeting in T 891C with EG&G & ASI personel to
discuss using dozer to assist drill with access to control side
hole. Conclusion: will place road fill with loader, through rough
slope areas, to access slide hole (57194) from east end of
landfill. Anticipate 1-2 weeks before various permits, etc. are
secured and road ready for access.

Checked remaining hole locations with Paul Jordan. Cleaned hole 59694, with Marcia (96 moved from original location). Other hole locations look ok. Commence drilling 59594 @ 12:45 PM. Drilled to 24' deep. Left RFP @ 4:15 PM.

(Page 21) Boring 59594

Location: Atop Rocky Flats Terrace toward west end of landfill; just North of west side. 75' north of flat terrace edge.

Mobile B-57 drill

Boyles Brothers

Drill with 3.25" ID Hollow Stem Augers

Cal Mod Drive Sampling

Push 3" Shells

Moss System

Water first encountered at 32'; measured @ 29.5'

Drilled 12/8-9/94

TD 41'

Install Piezometer: screened from 37.6' to 27.6' (details on page 26)

Installed 12/14/94

(Page 22) Boring 59594 cont.

0'-0.1' Topsoil: roots, silt.

ROCKY FLATS ALLUVIUM

0.1'-0.5' SILTY GRAVEL (GM): dark
brn.; damp; f.-crs.; organics.

0.5'-22' SANDY, CLAYEY GRAVEL (GC)
yellowish, brown, reddish-brown;
damp-moist (fines); generally
appears dense (material is too
coarse for accurate PR from drive
sampling); f. to crs., subangular-
subrounded (mostly quartzite), occ.
cobbles; f. to crs. sand; clayey
sand (SC) from approx. 7' to 7.3'.

GC, broken, angular* rock
(quartzite) with in greenish-gray,
moist clay (CL-CH), approx. 8.5'-9'
*fragmented via sampling
traces moist-v. moist, greenish-
gray clay (CL-CH) from 8.5' to 22'
med. dense? clayey sand, f. to crs.
from approx. 10'-10.5'
Cobble (fragmented rock) from
10.5'-11'

0'-2' Moss

rec. 2.0/2.0

2'-2' Cal Mod

refusal (bouncing)
@ 2'

2'-4' Moss

rec. 1.5/2.0

(gravels pulverized by
drill action)

4'-6' Moss

rec. 1.3/2.0

Note: v. slow, grinding,
rough drilling from 0'-22'
6-8' Moss rec. 1.5/2.0

8.5'-8.9' Cal Mod

refusal 50/5" (retain
bag sample)*

8.9'-10' Moss

rec. 0.5/1.1

10'-11' Cal Mod

15/95/6"; refusal 11'

rec. 1.0/1.0

11'-12' Moss

rec. 1.0/1.0; bag sample

12'-14' Moss

rec. 1.6/2.0

(Page 23) 59594 cont.

0.5'-22' SANDY, CLAYEY-GRAVEL (cont) 14'-16' Moss
rec. 1.2/2.0

Note: bulk sample, 0-22', contains pulverized rock (gravels pulverized by drilling action); appears finer grained than in place material.

22'-25' SANDY CLAY (CL-CH): yellowish, brown, some gray mottling moist; v. stiff, f.-crs. sand. hard below approx. 24' approx. 25'-26.5' CLAYEY SAND (SC): mottled gray, yellowish-brn.; moist; dense; f.-crs.; 30-40% mod. plastic fines

26.5'-32' SANDY CLAY (CL), some CLAYEY SAND (SC): yellow brown, some gray mottling; moist; v. stiff-hard; f.-crs. sand; occ. gravel and cobbles.

(Page 24) 59594 (cont.)

Weathered CLAYSTONE (displaced block?) from 31.3' to 32' (claystone is probably detrital; block is dry).

32'-35' poorly graded SAND, CLAYEY SAND (SP-SC): yellowish-brown; wet; dense-v. dense; f. grained.

35'-36' SANDY SILT (ML): gray-brn. mottled orange; wet; v. dense; v. f. sand;

36'-37.5' poorly graded SAND-CLAYEY SAND (SP-SC): as above, 32'-35' (*possibly slowly)

ARAPAHOE FORMATION

37.5'-37.8' CLAYSTONE/LEAN CLAY (CL): yellowish-brn., orange, gray (layered, mottled); damp-moist; hard. "Rock" Properties: highly weathered; plastic; soft.

37.8'-41' CLAYSTONE (CL): mottled

16'-18' Moss
rec. 1.4/2.0
18'-18.2' Cal Mod
60/2": refusal (bouncing)
rec. 3" cobble
wedged in shoe.

18.2-20' Moss
rec. 1.0'-1.8'
20'-22' Moss
rec. 1.0/2.0
22'-24' Moss
rec. 2.0/2.0
pp=2.5 @ 23'
=4.0 @ 24'
24' 12/8, 12/9
retain bulk sample
of cuttings, 0-22'
(in metal bucket)
24'-26.5' push Shelby
rec. 2.4/2.5
pp=4.25 tsf @ 26.4'
26.5'-27.5' Cal Mod
28/60/6" refusal
27.5'-28' Moss*
rec. 0.5-0.5
28'-30' Moss
rec. approx. 1.2/2.0
pp=4.5 tsf @ 27'

30'-32' Moss
rec. 1.2/2.0
32'-34' Moss
rec. 2.0/2.0
wet @ 32'
34'-35' Cal Mod
*5/105/6"; refused
*5 blows probably
from clean sands that
flowed into the auger
35-35.8' SPT 38/50/3"
refused; rec. 0.8/0.8
retain bag sample
35.8-38' Moss
rec. 2.2/2.2
pp=4.5 @ 37.7'
38'-38.9' push Shelby
refusal
(6,000 psi down press.)
rec. 0.9/0.9; bent tube
38.9'-41' Moss
sampler stuck in augers;
broke wireline trying to pull;
trip out augers
rec. 0.5/2.0

gray/yellowish-brn.; mod. wthered.; (upper sampler packed with slough)

(Page 25) Friday 12/9/94

On-site @ 8:00 AM waiting for ASIrig personel to arrive, and continue drilling 59594. Continue drilling at 10:00 AM. Completed hole at TD 41'. Left RFP at 3:45 PM. Will install monitoring well on Monday AM.

(Page 26)

37.8'-41' CLAYSTONE (cont.); plastic friable; soft; displays some thin laminations (iron and manganese stained bedding, sfcs., approx. horizontal). Soil Properties: damp; hard; lean clay (CL-"silty claystone"). Includes some v. f. silty-sandstone laminae.

Terminate @ 41'

Install monitoring well: 12/14/94

caved material, 41'-40'

#16/40 sand, 40'-25.5'

Bentonite (pellets) 25.5'-23.5'

Bentonite grout slurry 23.5'-0'

2" Blank PVC 39.6'-37.6'

2" .010" slotted

PVC screen 37.6'-27.6'

2" Blank PVC 27.6'- surface

(Page 27) Monday 12/12/94

On-site at 8:15 AM. Drill crew still repairing winch/wireline; won't be ready to install well until late AM. Laurie Host (ASI) will call me at Broomfield when ready to ream hole. Left RFP for Broomfield at 9:00 AM. Return to RFP at 11:00 AM. Hole eamed to 15'; broke A-rod on auger plug. Left RFP at 1:45 PM.

(Page 28) Tuesday 12/13/94

On-site at 12:45 PM. Laurie Host said drill crew will be ready to install well at 2:00. Crew unable to install well, due to sand bailer needing decontamination (decon can't be performed until tomorrow AM). Well installation will probably commence Wednesday at 8:00. Discussed piezometer installation requirements with Mark Wood-the geotech (EG&G). Piezometers will also be used for water sampling, thus need to be installed with 2" casing (this requires reaming out the borehole with larger diameter augers prior to installation). Left site at 4:00 PM.

(Page 29) Wednesday 12/14/94

On-site at 8:25. Jeff (ASI) informed me that the geotech rig may be shut down next Mon. and Tues. due to a lack of H&S personel. Called Scott Hollowell to inform him of this. Commenced well installation at 59594, at 9:15 AM. Observed well construction through placement of 2' bentonite pellet seal. Left RFP for Broomfield at 11:20 AM. Attended RCRA and HAZCOM CBT at

Interlocken in the PM.

(Page 30) Thursday 12/15/94

On-site at 8:15 AM. Auger decon. proceeding; rig won't be ready to drill next hole (57094) until late AM at the earliest. Completed RCRA review/checklist. Left RFP @ 10:15 AM. Returned to site at 11:50 AM. Hole 57094 has been designated in an RCA. Commence drilling at 3:35 PM, at 10.5' deep; frisk out from RCA. Left site at 4:30 PM.

(Page 31) Boring 57094

Location: N. edge of road along Surface Interceptor Ditch (SID), east portion of landfill (along section line through east slump).

Mobile B-57

Boyles Brothers

Drill with 3.25" ID Hollow Stem Auger

Moss Sampling

Cal Mod Drive Sampling

3" Shelby Tube (Push)

Water encountered at 32' perched on cs surface at 34'

Drilled 12/15-16/94

TD @ 40'

Installed piezometer, 12/17/94

Note: samples re-examined/ re-interpreted 2/2/95.

(Page 32) Boring 57094

<u>ROADFILL</u> (replaced waste fill)	0'-2' Moss
0'-4.5' SANDY, CLAYEY GRAVEL (GC):	rec. 1.2/2.0
mixed dark brn., mod. brn.,	2'-4' Moss
yellowish-brn.; damp; moist (var.);	rec. 1.7/2.0
appears med. dns., f.-crs. gravel;	4'-6' Moss
	rec. 1.7/2.0
	v. easily drilled.
	from 5'-6' retain bag
	sample from 5'-5.5'
<u>FILL</u>	6'-8.4' Push Shelby
4.5'-7.5' CLAYEY SAND (SC): dark	easy push to 7.5'
brn.; v. moist- wet; *loose; f.-crs.;	grad. harder to 8.4
30-40% mod. plastic fines.	rec. 1.6-2.4
7.5'-8.5' SANDY CLAY (SC): dark	*moisture from SID
brn.-black; v. moist; stiff-v. stiff;	pp=3.0 tsf @ tube bot.
SANDY CLAY (CL): 7.6' tube bottom?	8.5-10.5' Cal Mod
8.5-10.5' probably FILL; (appears	5/10/10/12
mixed); re-examined 2/2/95	rec. 2.0/2.0
8.5-10.5' SANDY, CLAYEY GRAVEL-	pp=2.5 tsf* @ 10.5'
GRAVELLY, SANDY CLAY (GC-CL):	bag samp., 10'-10.5'
yellowish-brn, mod. brn., mottled	*Note: clay matrix appears
orange, some gray; moist-v. moist;	softer above 10.2'
stiff; subrounded to ang. gravel;	(*appears mixed or disturbed)
mod. plastic fines; some striat.	
/slickensides * (possibly mech.-	10.5 12/15 / 12/16
gravels smearing clay while drive	hole dry at 9:00 AM
sampling);	

appears consistently SANDY CLAY
(CL): f.-med. sand from 10.2'-10.5'

30-40% mod. plastic fines.

(Page 33) 57094 cont.

yellowish-brn., v. moist, CLAYEY
GRAVEL (GC): @ 11.3' (tube bottom);
clay matrix appears soft @ 11.3'
10.5'-22' CLAYEY GRAVEL (GC), orange
brn., predom. yellowish-brn.,
v. moist; med. dense; (?soft to firm
clay matrix) CLAYEY GRAVEL, f.-crs
gravel from 10.5' to 17.5'
*(includes mottled/mixed greenish
gray clay). Appears mixed with
subrounded-ang. gravels. Possibly
slide RFP alluvium material?
CLAYEY GRAVEL to GRAVELLY CLAY
(GC-CL): stiff-v.stiff from 17.5'
to 18.5'
18.5'-20' SANDY CLAY: mod. brown-
yellowish brn.; moist-v. moist;
stiff; f.-crs. sand, some f. gravel
20'-22' SANDY, CLAYEY GRAVEL (GC):
yellowish-brn.; moist-v. moist;
med. dense; f.-crs. gravel; f.-crs.
sand; 20-40% mod. plastic fines;
(generally as above 18.5')
22'-26' SANDY CLAY *(CL): mod.
yellowish-brn.; moist-v. moist; v.
stiff; f.-crs. sand, some f.
gravel. [COLLUVIUM SLIDE ?]

(Page 34) 57094 cont.

Note: Colluvium slide material,
22'-34' includes varying amount of
claystone detritus?/fragments
stiff(?) from 24' to 26'
26'-32' LEAN CLAY with SAND (CL):
yellowish brn., mottled orange,
gray; moist-v. moist; stiff-v. stiff;
scattered frags.; subrounded gravel
CLAYSTONE, highly to severely
weathered, shows very faint rock
structure; from 26'-26.5'
32'-34' CLAYEY GRAVEL (GC): yellowish
brn.; wet; dense; f.-crs. gravel;
subang.-subrounded gravel; mod.-
plastic fines. Appears mixed/
chaotic. Base of a possible slide?

10.5'-12.5' push Shelby
softer, easier push from
11'-11.5'; max. down press.
@ 6,000#
rec. 0.8/2.0, bad crimp tube
12.5'-14.5' Cal. Mod.
14/11/15/18, rec. 1.8/2.0
14.5'-16.5' Cal. Mod.
with Brass Liners
6/10/15/14
rec. 1.3/2.0
retain brass liners (6")
14.5'-15'
16.5'-18.5' Cal. Mod.
9/17/22/18 retain bag sam.
18.-18.5', pp=2.25 @ 18'
18.5'-20' Push Shelby
steady push to 20' (v. hard
at 20') rec. 1.3/1.5 dented
bottom 6" of tube
pp. 1.75 @ 19.8 tube bottom
20'-22' Cal. Mod.
9/17/21/20, rec. 2.0/2.0
22'-24' Cal. Mod.
11/20/38/44
pp=2.75 @ 23'
rec. 1.8/2.0

24'-26' Cal. Mod.
6/17/19/22 *
rec. 1.5/2.0
(sample disturbed by driving
rock [gravel/cobble] through
CL-clay appears stiff
26'-28' Cal. Mod.
10/16/23/32
rec. 2.0/2.0, pp=2.0 @ 28'
v. slight dent @ tube bottom
28'-30.5' Push Shelby
rec. 2.0/2.5
pp=1.75 tsf @ 30'
30.5'-32.3' Cal. Mod.
8/13/22/50/4"
rec. 1.8'/1.8'

ARAPAHOE FORMATION

34'-39' CLAYSTONE: yellowish-brn., mottled orange, gray; mod. weathered friable; soft; var. shows subhor. laminations (thin-v. thin); some iron stained bedding, fracture surfaces (v. narrow tight apertures). Soil Properties: damp; hard; mod. plastic (CL).	wet sampler, sample @ 32' drill to 32.5'
39'-40' CLAYSTONE: dark gray; frsh slightly weathered; friable; soft.	32.5'-34' Moss rec. 1.2/1.5
TD @ 40'	34'-36' Moss (bag samp. 34-34.5') rec. 2.0/2.0 pp=4.5+ tsf
	36'-38' Moss rec. 2.0/2.0
	38'-40' Moss rec. 2.0/2.0, pp=4.5+
	Terminate at 40'

(Page 35) Friday 12/16/94

On-site @ 8:10 AM, ASI crew awaiting monitoring instrument to continue boring 57094. Continue drilling 57094 at 9:30 AM. Quit for "short lunch break" at 12:30 PM. Continue drilling at 2:00 PM. Complete 57094 at TD 40', at 3:00 PM. Left RFP at 3:40 PM.

(Page 36) Monday 12/19/94

Arrived on-site at 8:00 AM. No drilling at RFP today due to high winds and lack of personnel. Left RFP for Bloomfield at 8:20 AM. Well was installed in 57094 on Saturday, 12/17/94. Well construction details:

Caved material: 37.5'-40'
Bentonite Pellets: 36'-37.5'
#16/40 sand: 22'-36'
Bentonite Pellets: 20'-22'
Grout slurry: 0'-20'
2" Blank PVC (sump): 34'-36'
2" .010' slotted PVC: 24'-34'
2: PVC blank: 0'-24'

(Page 37) Tuesday 12/20/94

No work at RFP today due to lack of H&S person. Met with Fred Grigsby at Interlocken to discuss his faulting studies, from mid-late afternoon.

(Page 38) Wednesday 12/21/94

On-site at 7:50 AM. Rig won't be ready to drill until approx. mid. AM. Left RFP for Bloomfield at 8:15 AM. Return to RFP at 10:25 AM. Set up rig on 59294. Commence drilling at 11:00 AM. Complete hole at 32' TD at 3:00 PM. Left RFP at 3:45 PM.

(Page 39) Boring 59294

Location: South edge of road along SID, within 19.5' of slide area; west portion of landfill just east of gull with IHSS 196 ponds.

Mobile B-57

Boyles Brothers

Drill with 3.25" ID Hollow Stem Augers

Moss Sampling

3" Shelby Tube (push)

Cal Mod drive sampling

water not encountered
drilled 12/21/94
TD @ 32'
Installed piezometer, 12/22/94

(Page 40) 59294 cont.

ROADFILL shoulder/replaced 0'-2' Moss
waste fill 0'-0.1 grass roots soil rec. 1.5/2.0
0.1-9.5' SANDY, CLAYEY GRAVEL, 2'-4' Moss
SANDY CLAY (GC,CL): mixed mod. rec. 1.5/2.0
brn., dark brn.;damp;appears dense; 4'-6' Moss
f.-crs. gravel; some cobbles; mod. rec. 1.2/2.0
plastic fines;mostly H-Mod. brown 6'-8' Moss
below 2', mostly GC below 2' rec. 1.2/2.0
8'-8' Cal Mod
refusal at 8': no adv.

COLLUVIUM/SLIDE MATERIAL

9.5'-10.7' sandy clay (CL): yellow-
brn., mottled orange, some gray; mostly rough drilling,
moist; v. stiff; mod. plastic; 0-10', 8'-10' Moss
f.-crs. sand. rec. 0.8-2.0'
10.7'-12' GRAVELLY, SANDY CLAY TO 10'-12' Cal Mod
SANDY CLAYEY GRAVEL (CL-GC):yellow- *10/21/28/29 BH00170AS
brn., mottled;moist;v.stiff;med. rec. 2.0/2.0; (bag samp.
dense; f.-crs. gravel in clay 10'-10.5')
matrix. 12'-13.9' BH00171AS Push
Shelby easy push to 13.5'
somewhat harder (up to
1,000#) to 13.9'
rec. 1.2/1.9' (is in tube bot.
mod. weathered) drill ou to
14', 14'-16' Cal Mod

CLAYSTONE/SLIDE MATERIAL

12'-14' CLAYSTONE: yellowish-brn.,
mottled orange/gray; mod. wthered;
friable;soft;closely fractured.

(Page 41) 59294 cont.

SILTSTONE/SLIDE MATERIAL

14'-15.4' SILTSTONE: H. brn.-yellow,
brn.; mod.-sev. weathered; friable;
soft;mixed,soft rock frags. (shows 14'-16' Cal. Mod.
some breccia structure). Soil 12/13/12/14
Properties: damp;stiff SANDY SILT rec. 2.0/2.0
(ML). Sharp smooth, flat, contact
with clay/claystone @ 15.4' (roots
penetrating from 15' in siltstone
to 15.6' in clay/cs)

pp=4.0+ at 16'
blow counts indicate
softer material
BH00172AS

ARAPAHOE FORMATION

15.4'-17' FAT CLAY (CH)/CLAYSTONE: 16'-18' Push Shelby
dark gray;moist;stiff-v.stiff. steady increase to
occ. roots; some iron staining. 4,000 psi, rec. 1.1/2.0
Rock Properties: sev. weathered; 18'-19' Cal. Mod.
plastic;soft. 18/ 50/6";refusal @ 19'

17'-29' CLAYSTONE: mod.-highly weathered, dark gray, some orange iron staining along bedding; occ. rootlets penetrating along fractures; friable; soft.
Soil Properties: damp, hard,
FAT CLAY (CH): mod. weathered below 18'; no roots below 19'; slickensides (striations along horizontal surfaces.) @ 21' rec. 0.9/1.0
19'-21' Moss rec. 2.0/2.0

(Page 42) 59294

17'-19' CLAYSTONE (cont.) occ. slickensides observed from 21'-29' orange (heavy iron stained) from 22.5'-23' rare iron staining/slightly weathered from 25'-28' appears locally crushed/pulv.* some vertical fractures, from 25'-29'.
21'-23' Moss rec. 2.0/2.0
23'-24.7' Push Shelby (ASI BH00173AS) increase up to 6,000#
rec. 1.5/1.7, drill out-25' 25'-27' Moss
rec. 2.0/2.0 29'-29.7' Cal Mod
70/8"; refusal
*crushed texture possibly mechanical
drill out to 30'
29'-32' SILTY CLAYSTONE: mod.-dark gray, fresh; friable; soft; thinly laminated; samples break along .25" thick horizontal laminae. Soil Properties: damp-dry; hard; mod. plastic to low plastic (CL); Terminate at 32' 30'-32' Moss
rec. 2.0/2.0

Install piezometer 12/22/94:

2" PVC screen: 15'-17'
16/40 sand: 19'-10'
Bentonite Pellets: 19'-23'
caved native: 23'-32'
Bentonite Pellets: 10'-8'
Bentonite grout: 0'-8'

(Page 43) Thursday 12/22/94

Worked in Broomfield for most of the day. On-site at RFP, at 3:00 PM to check well installation progress in Boring 59294, and check with ASI regarding continuation of project after holidays, next hole location, etc. Well was installed in 59294 by late afternoon. Left site at 4:00 PM.

(Page 44) Tuesday 1/3/95

Return to Bloomfield from California. Spoke with Jegg Harwell (ASI), mid-PM. Drill crew is pre-occupied with radworker II training/recertification today and tomorrow. Drilling is expected to resume on Thursday, 1/5/95.

(Page 45) Wednesday 1/4/95

Worked in Broomfield for the day.

(Page 46) Thursday 1/5/95

Arrived at RFP at 9:40 AM. Renewed dosimeter. Adjusted boring locations at *'s 91 (*91 moved from E/W road to Flats edge above #97), 97, 96, 83, 90, and 76. Commenced drilling 57494 at 2:00 PM. Completed drilling 57494 at 4:30 PM (36.5' TD). Left RFP at 5:00 PM.

(Page 47) Boring 57494

Location: S side of E/W road, 230' east of 57094.

Mobile B-57

Boyle's Brothers

Drill with 3.25" ID Hollow Stem Augers

Moss Sampling

3" Shelby Tube (push)

Cal Mod drive sampling

water not encountered

drilled 1/5/95

TD @ 36.5'

Grout Backfill on 1/6/95

(Page 48) 57494

ROADFILL Mostly replaced claystone 0'-2' Moss

0'-7' SANDY, GRAVELLY CLAY (CL): rec. 2.0'/2.0'

mod. brn.; moist; v. stiff; f.-crs. 2'-4' Moss

sand, mostly fine gravel. rec. 1.7'/2.0'

H. brn., with some orange gray 4'-6' Moss

mottling; dry to damp below 0.6'. rec. 1.5'-2.0'

6'-8' Cal. Mod

COLLUVIUM 9/13/18/17

7'-8' GRAVELLY CLAY (CH): rec. 1.5'/1.5'

dark brn.; moist; v. stiff; f.-crs.; 8'-10.5' Push Shelby

subangular-subrounded gravel. rec. 2.4'/2.5'

pushed @ approx. 2000#

ARAPAHOE FORMATION bottom 0.5 somewhat disturb.

8'-11' CLAY - CLAYSTONE (CL-CH): (sample pushed back into

yellowish-brn., mottled orange/gray tube, was slipping out)

v. moist; firm-stiff. *Rock pp=1.0 tsf @ 10.4'

Properties: severely weathered; 10.5'-13.0' Shelby

plastic; soft. rec. 2.5/2.5'; pp=4.0 @ 13'

11'-34.3' CLAYSTONE: mottled gray, 13'-14.5 Moss

yellowish-brn.; mod. weathered; rec. 1.5/1.5'

plastic-friable; soft. Shows some 14.5'-16.5' Moss

fracturing, generally massive. rec. 1.6/2.0'

Soil Properties: damp; hard; mod.- 16.5'-18.5' Moss

highly plastic (CL-CH). rec. 2.0/2.0

Includes some 0.5" iron

concretions @ 18'.

(Page 49) 57494

11'-34.3' CLAYSTONE (cont')

mod.-slightly weathered below 19' 18.5'-20.5' Push Shelby

iron concretions at 21.4' rec. 1.6-2.0'

dark gray to black, carbonaceous push up to 8,500 psi

from 22.5-23.7' 20.5'-22.5' Moss

orange, heavily iron stained, rec. 1.5/2.0

22.5'-24.5' Moss

numerous iron concretions; from
24.5'-26.2'.

rec. 2.0/2.0
24.5'-26.5' Moss

dark gray to black; carbonaceous
with some iron staining, from
31'-32'.

rec. 2.0/2.0
26.5'-28.5' Moss
rec. 1.6/2.0
28.5'-30.5' Moss

H. gray, v. little iron staining
below approx. 32.5'

rec. 2.0/2.0
30.5'-32.5' Moss
rec. 2.0/2.0
32.5'-34.5' Moss

34.3'-36.5' CLAYSTONE: mod. gray;
fresh; friable; soft; massive.

rec. 2.0/2.0
34.5'-36.5' Moss
rec. 2.0/2.0

Soil Properties: damp; hard;
(CL-CH).

Terminate at 36.5'
Grout Backfill

(Page 50) Friday 1/6/95

Worked in Broomfield for most of the day. On-site at RFP approx.
2:00 PM. Checked boring 59794 location with driller to see if
access looked feasible. Will attempt to set-up rig on hole after
decontamination is complete. Left site at 3:15 PM.

(Page 51) Monday 1/9/95

On site at 8:10 AM. ASI preparing to start 59794 (hole is located
in the original landfill, thus within an RCA. Checked hole
locations at *69, *71, (moved number *71 approx. 10' west.
Commenced drilling 59794 at 1:30 PM. Quit drilling at 19', at 3:15
PM.

(Page 52) Boring 59794

Location: West portion of landfill, upper slope just east of ravine
and west of trees (IHSS 196). 10' north of 58593.

Mobile B-57

Boyles Brothers

Drill with 3.25" ID Hollow Stem Augers

Moss Sampling

3" Shelby Tube (push)

Cal Mod drive sampling

water not encountered

drilled 1/9-10/95

TD @ 25.2'

Installed Piezometer (page 51)

(Page 53) 59794

WASTE FILL

higher blows due to crs.

0-0.2' SILTY GRAVEL (GM): mod. brn. gravel/cobbles?

damp; grass roots.

0'-1.3' Cal Mod

0.2'-11' SANDY, CLAYEY GRAVEL (GC): 16/29*/38/3" bounce @ 1.3'

dark brn.; damp-moist; f.-crs. sands refusal @ 1.3'; rec 0.6/1.3

& gravel, subangular; med. dense;

drill out to 2'

locally loose-v. loose.

2'-4' Cal Mod

mottled gray/yellowish-brn.; 30-40% mod. plastic fines; some claystone frags from 2.8-3.5'.	16/23/18/9; rec. 2.0/2.0
black SILTY SAND (fine graphite); broken glass, loose-v.loose; some voids?, from 3.5'-8.5'.	4'-6' Cal Mod
mixed gray, black, orange, (GC); med. dense; moist from 8.5' to 11' (graphite from 10-11')	5/1/2/1; rec. 0.5/2.0
	6'-8' Cal Mod
	1/1/1/1; rec. 0.7/2.0
	8'-10' Cal Mod
	2/4/19/23; rec. 2.0/2.0
	10'-12' Cal Mod
	16/40/27/34; rec. 2.0/2.0

ROCKY FLATS ALLUVIUM

11'-15.5' SANDY, CLAYEY GRAVEL (GC): orange brown; moist; med. dense-dense; f.-crs., subangular gravel, some cobbles; mod. plastic fines.	12'-12.5' Cal Mod
fine CLAYEY SAND (SC): orange; moist med. dense; from 13-14.8'.	70/6"; refusal @ 12.5'
	rec. 0.3/0.5
	drill out to 13'
	13'-15' Cal Mod
	12/18/26/26
	rec. 2.0/2.0

(Page 54) Rocky Flats Alluvium (cont.)

GC, as above, from 14.8'-15.5'	15'-17' Cal Mod
[contact with RF Alluvium approx. 25 ⁰ -30 ⁰ , irregular; appears depositional	

ARAPAHOE FORMATION

15.5'-23.5' CLAYSTONE: gray-brn.; mod.-highly weathered; plastic-friable; soft. Soil Properties: damp; hard; high plast (ch); #'s blows mod.-stiff; 15.5-16' sample seems harder.	14/12/28/48
mod.-dark gray; slightly weathered; friable below 16.5'; occ. orange iron staining along fractures, bedding surfaces; occ. shows subhor. bedding.	17'-18' push Shelby
Locally silty SILTY CLAYSTONE (CL): below 18'	hard push up to
mostly yellowish-brn., mottled orange, gray; mod. weathered; friable from 20'-23'	8000#; rec. 1.0/1.0
iron staining along fractures; friable; slightly weathered from 23'-	18'-18.8' Cal Mod
Vertical fracture; iron stained @ 23'.	37/50/3"; refusal @ 18.8'
23.5'-25.2' SILTY CLAYSTONE: gray; fresh; friable. Soil Properties: damp; hard; low plastic (CL)	rec. 0.8'/0.8'
Terminate at 25.2'	drill out to 19'
	19' 1/9:1/9
	19'-21' Moss
	rec. 2.0/2.0; bag 20.5-21'
	dry hole @ 10:30 AM
	21'-23' Moss
	rec. 2.0/2.0
	23'-23.5' Cal Mod
	80:6; refusal
	rec. 0.5/0.5
	23.5'-24.5' Moss
	rec. 1.0/1.0
	(sample appears pulverized by drill action w/ Moss
	24.5'-25.2' Cal Mod
	48/50/2; refusal
	bag sample
	Installed Piezometer

(Page 55) Installation of Piezometer

2" PVC: 11-21'
.010" screen
10/40 sand 10'23" deep well
bentonite pellets: 8'-10'
sump (blank) PVC: 21'-23'
caved material: 23'-25.2'
grout (bentonite slurry): 0'-8'

(Page 56) Tuesday 1/10/95

On-site @ 8:15 with Mike Mooers, Mark Yaskanin. Continue drilling 59794 at 10:30 AM. Complete 59794 at 12:00 PM. Left RFP at 12:30 PM, with Mike Mooers, Mark Yaskanin, and Scott Hollowell to visit Advanced Terra Testing soils laboratory in Lakewood. Toured laboratory facilities and returned to RFP @ 3:00 PM. Well was installed in 59794 by 3:30 PM. Toured original landfill area with Mark Yaskanin and Mooers; left site at 5:30 PM.

(Page 57) Wednesday 1/11/95

On-site at 8:10 AM. Drill crew on decon. pad cleaning augers. Will be checking core with Mike Mooers and Mark Yaskanin when they can get on-site through security. Looked at core from borings *75 (deep MW), *92, *77, *70. Moved rig 6' south of 59794, to drill adjacent deep geotech./MW boring #71194. Commenced drilling at 12:35 PM. Stopped drilling at 26', to set surface casing for deeper bedrock coring, at 2:00 PM. Walked landfill with Mooers; discussed work plan, further boring locations. Left RFP for Broomfield at 2:50 PM.

(Page 58) Boring 71194

Location: 6' south of 59794.

Mobile B-57 (2 rigs: 1 auger, 1 core)

Boyles Brothers

Drill with 3.25" ID Hollow Stem Augers: 8.25" ID for casing
3" Shelby Tubes

Cal Mod drive sampling: H.X. Core w/ clear water below 26'
water not encountered-very moist to wet fill at 11.0'-11.3'
(note: HX core = 3.5" OD, = 2.5" ID)

drilled 1/11/95, 1/18-23/95

TD @ 150'

(Page 59) Boring 71194 (cont.)

WASTEFILL

0'-11.3' CLAYEY GRAVEL, SAND (SC): without sampling.
(refer to log of 59794 for v. rough drilling
detailed description of fill) cobbles? at 10'
black, v. moist-wet clayey sand (SC) 11'-12.3' Cal Mod
[fill], from 11'-11.3' 31/34/50/4"

refusal at 12.3'

rec. 1.3/1.3

ROCKY FLATS ALLUVIUM

11.3'-13.5' SANDY, CLAYEY GRAVEL
(GC): orange-brown; moist; med.
dense-dense; f.-crs. gravel, some
cobbles.

bag 11.5'-12.3'

drill out to 13'

13'-14' Cal Mod

24/17 (short drive)

rec. 0.5/1.0

ARAPAHOE FORMATION

13.5'-15' FAT CLAY/CLAYSTONE (CH): yellowish-brn., mottled orange, gray; damp-moist; v. stiff; [(Cal Mod sample) pp=4.5+ tsf @ 14'] but blows indicate softer; high plast; Rock Properties: severely weathered; plastic; soft.
15'-24' CLAYSTONE: gray, gray brn.; mod.-slightly weathered; friable; soft. Soil Properties: damp; hard; high plastic (CH).

(Page 60) Boring 71194

24'-27' SILTY CLAYSTONE (CL): gray; fresh; friable; soft. Soil Properties: damp; hard; low-mod. plasticity to 27'; below 27' predominantly claystone; generally appears massive (core has numerous hor. polished breaks, and is freq. ground adjacent to breaks due to drill action)
27'- CLAYSTONE (CH): dark gray; fresh; friable; soft; massive. Soil Properties: damp; hard; high plas.; Locally SILTY CLAYSTONE (CL): occ. brn., rounded, hard cs inclusions (possibly iron concretions) some vert., slick surfaces (polished w/out distinct striations. some slick surfaces at 30⁰-60⁰ pump from 33'-35' (poor recovery of run 32'-37') near vertical, slick fracture surfaces from 37'-38'

(Page 68) cont. from page 60 71194

27'-150' claystone (cont.) near vert., slick fracture surfs. spotty, yellowish-brn. (iron staining) within rock ground mass (not along fracture surfaces) from 37'-38' apprs crushed, soft-consistency, some slickensides from 43'-443.5' (possibly mechanical, br mechanical in part?) hard, subrounded, brn. cs frags. (rip up clasts?), at 60.5' occ. black (manganese?) stained fracture surfaces (noted) from 60'-61' (partially open-30⁰ fracture coated w/ black (manganese?))

14'-16' Push Shelby
push up to 3000 #
rec. 2.0/2.0
16'-17.2' Push Shelby
v. hard push below
17' (up to 6000#)
rec. 1.2/1.2

drill out to 24'
24'-26' Moss
rec. 1.2/2.0

set 6" ID schedule
80 PVC casing to 26';
grout in place 1/12/95
26' 1/11/95:1/18/95
26'-27' H.X. Core
Full fluid return
rec. 0.6-1.0
27'-32' H.X. Core
11:35-11:56, full return
21 mins; rec. 3.4/5.0
32'-37' H.X. Core
12:05-12:31, full return
26 mins.; rec. 2.3/5.0
37'-42' H.X. Core
full fluid return
rec. 3.5/5.0
(note: drilling reduced
(fluid) rate
after poor recovery
in previous (32'-37')
run; rec. somewhat improved)

42'-47' HX core;
stop @ 45' @ 1:30PM
resume at 3:10 PM
Full fluid return
rec. 2.6/5.0
47'-52' H.X. core
3:53-4:07 (14 mins)
driller signif. increased
down pressure, prod. vast
improved recovery
rec. 5.0/5.0
52' 1/18:1/19
52'-57' H.X. Core
rec. 1.7-5.0
57'-62' H.X. core
rec. 4.3/5.0

material.. 62'-66' H.X. Core
mainly SILTY CLAYSTONE (CL): from rec. 1.7'/4.0
62.5'-64' (core logged to 63.7')
Total Depth 150'

(Page 61) Thursday 1/12/95
Worked in Broomfield all day. Drill crew finished setting surface casing in 71194 by mid afternoon.

(Page 62) Friday 1/13/95
On-site at 11:00 AM. High winds keep delaying decon. (rig 13 on pad). Returned to Broomfield at 11:45 AM. Note: Mark Wood delivered two copies of new 1"=100', 2-foot topo contour map of landfill area. Returned to RFP at 1:00 PM. High winds still preventing completion of decon. Unlikely that drilling on next boring (56994 is planned) will commence today. Proceeding with mapping of landfill area on new topo base. Left site at 4:40 PM.

(Page 63) Monday 1/16/95
On-site at 8:25 AM. Crew setting up on 56994. Mapped in landfill area. Commenced drilling at 13:05. Finished at TD (29') at 4:20 PM. Left RFP at 4:50 PM.

Boring 56994
Location: Center landfill, upper slope (above upper scarp).
Mobile B-57
Boyles Brothers
Drill with 3.25" ID Hollow Stem Augers
3" Shelby Tubes
Moss Sampling
Cal Mod drive sampling
water first encountered @ 22'; measured at 16.7' on 1:17 AM.
drilled 1/16/95
TD @ 29'
Install Well 1/17/95

(Page 64) Boring 56994

<u>WASTE FILL</u>	0'-2' Cal Mod
0'-10' SANDY, CLAYEY GRAVEL (GL):	15/17/24/33
mod.-dark brn.; damp; med. dense;	rec. 2.0/2.0
f.-crs. sand & gravel; occ. cobbs.	2-4' Cal Mod
black; moist; from 2.3-2.5'	20/13/13/18
dark brn.-black; damp-moist; from	rec. 1.6/2.0
3.3-5'	bag sample 2.6'-3.4'
dry; H. orange-brn.-mod. brn. from	4'-6' Cal Mod
3.1-3.3'	18/20/24/16
loose to med. dense; v. moist; some	rec. 0.6
orange mottling; soft clay matrix	6'-7.9' Cal Mod
from 6'-10' (piece of wire at 9.5')	10/6/8/18/5"
	bouncing 7.9'
10'-11' SANDY CLAY (CL): mod.	rec. 0.9/1.9
gray-brown, some green mottling;	bag samp. 6-6.9'
v. moist; firm; f.-crs. sand; some	attempted Cal Mod 8'
gravel	bouncing @ 8'

increased GRAVEL (GC-CL): from
10.8'-11'

drill out to 9'
v.rough drilling to 8.9'
9'-11' Cal Mod
12/11/6/12;rec. 2.8/2.0
11'-13' Cal Mod

ROCKY FLATS ALLUVIUM

11'-12.2' SANDY CLAY (CL): orange
brn.;moist;firm-stiff.
12.2'-14' CLAYEY SAND (SC): orange
brn.;moist;med. dense;fine;med.
sand (minor).

6/7/10/16;rec. 2.0/2.0
13'-15' Push Shelby
push up to 3000#
rec. 2.0/2.0
bottom of tube slightly
dented
0-11'retain bulk sample
of cuttings (bucket)

(Page 65) 56994 (cont.)

14-15' SANDY CLAY (CL); yellowish
brn., mottled orange,gray;moist;
v.f. sand, some crs. sand
(description based on tube bottom
at 15').

15'-23' CLAYEY SAND w/ GRAVEL
(SC): orange-brn.;v.moist;loose;
f.-crs. sand, some f. gravel;
mod. plastic fines.

v.moist to wet (traces of free
water) from 19.5'-22'

CLAYEY GRAVEL,some cobbles (GC):
from 20'-21';wet from 22'-24'
fine (SC) from 21.5'-23'

CLAYEY GRAVEL (GC): from 22.5-23' :
23'-24' SAND, CLAYEY SAND (SC-SP):
orange-brn.;wet;loose;fine;v.heavy
iron stain at 24'.

24'-24.5' GRAVELLY CLAY (CL):
yellowish-brn.,mottled orange-
gray;v.moist;stiff;f.-crs. gravel
abrupt contact w/ cs

15'-17' Cal Mod
6/9/10/9;rec. 2.0/2.0
retained bag sample,
15'-16'
17'-19' push Shelby
push up to 3000 psi
rec. 1.7/2.0
19'-2.0 Cal Mod
8/7/19/18 rough drilling
20-21';rec. 1.0/2.0
21'-23' Cal Mod
8/9/9/35;rec. 0.8/2.0
23'-25' Cal Mod
13/7/10/24
wet sampler 22'
rec. 2.0/2.0
25'-27' push Shelby
push up to 7000#
rec. 2.0/2.0
27'-29' Moss
rec. 2.0/2.0

ARAPAHOE FORMATION

24.5'-29' CLAYSTONE: dark gray;
fresh;friable;soft;generally
appears massive. Noted slickensides
on 60° fracture surface at 24.8'
Terminate at 29'

install piezometer
1/17/95 details page 66

(Page 66) Well installation in 56994

Screen: 14.5-24.5'

Sand:12.5'-27'

Bentonite Pellets: 9.5'-12.5'

Grout bentonite: 0-9.5'

TD @ 27'

On-site at RFP at 2:50 PM. Checked with Jeff H. regarding

tommorrows schedule. Left site at 3:45 PM.

(Page 67) Wednesday 1/18/95

On-site at 8:15 AM. Crew preparing to commence coring deep portion of 71194 (below 26'). Started drilling at 11:00 AM. Advanced 71194 to 52'. Left RFP at 5:05. Note: Auger rig set up on 57194; ready to drill tommorrow AM.

(Page 69) blank

(Page 70) Thursday 1/19/95

On-site at 8:05 AM. Commence drillind 57194 at 9:00 AM. End drilling at 2:10 PM, at 32'. Crew will ream hole to set 6" PVC casing (for deeper drilling via rotary core) tommorrow, and set casing tommorrow or monday AM. Logged core in 71194, from 52' to 66'. Left RFP at 4:00 PM.

Boring 57194

Location: Central landfill, mid-upper slope (below upper scarp/within slide)

Mobile B-57

Boyles Brothers

Drill with 3.25" ID Hollow Stem Augers

3" Shelby Tubes

Moss Sampling

Cal Mod drive sampling

water not encountered to 32'

drilled 1/19/95, 1/27 to 2/2/95

TD @ 150'

(Page 71) 57194 (combined with page 72)

WASTEFILL/SLIDE

0'-3.2' SANDY, CLAYEY GRAVEL (GC):	0'-2' Moss
orange-brn, mod. brn. (mixed); dry-	rec. 1.5/2.0
moist (var.); med-dense; some cobb.	2'-2' Cal Mod
3.2'-4' CLAYSTONE/SLIDE: gray-	bouncing @ 2'; refusal
brn., mottled orange; mod.	2'-3' drill out with
weathered; friable; soft; somewhat	center plug bit
disturbed; some slickensides.	3'-5' Cal Mod
10 ⁰ , planar smooth/slickensides	23/20/16/20
plane, within dark brn.-black,	rec. 1.8/2.0
moist clay (CH), clay is 0.5"	5'-7' Cal Mod
thick at 4' deep (severely	19/25/32/48
weathered claystone)..	rec. 1.5/2.0
	7'-8.9' push Shelby
	push up to 8,000#
	rec. 1.7/1.9; bottom 2"

ARAPAHOE FORMATION

4'-4.3' CLAY (CH)/CLAYSTONE: gray;	of tube badly dented
moist; v. stiff; occ. rootlets;	drill out to 9'
shows some slickensides. Rock	9'-10.4' Cal Mod
Properties: severely weathered;	20/40/50/5"; refusal 10.4'
plastic; soft; spotty caliche.	rec. 1.4/1.4
4.3'-5.3' CLAYSTONE: gray brn.,	10.5'-11.9' Cal Mod
mottled orange; highly weathered;	18/35/50/4"; refusal 11.9'

plastic-friable;soft;closely fractured;somewhat disturbed?;occ. precipitate (caliche)
5.3'-28' CLAYSTONE: gray-

rec. 1.4/1.4
drill out to 12';bag samp.
11'-11.9'
12'-13' push Shelby;
v.hard push; dented bottom
rec.0.5/1.0, no sample

(Page 73) 57194 (cont.)

5.3'-28' CLAYSTONE (cont.):gray-brn.;mod. weathered;friable;soft;generally mod. to closely fract.

see page 71 for details of sampling and logging to 13' deep.

(freq. iron stained fractures, bedding surfaces [hor. bedding]; blocky texture.*

3'-15' Moss;rec. 2.0/2.0

vertical;heavily iron-stained

15'-17' Moss

frac. (joint) from 9.2'-10'

rec. 2.0/2.0

pockets (vugs), fracture coatings of white, crystalline prec.

17'-17.9' Cal Mod

(gypsum); from 9'-15'

32/50/5"; rec. 0.9/0.9

Soil Properties: damp;hard;high plastic (CH);Includes occ. iron concretions.

bag sample 17-17.9'

SILTY CLAYSTONE (CL): from 19.5'-22'

drill out to 18'

local interbeds/laminae of silty claystone (CL) below 22'

18'-20' Moss:

somewhat decreasing fracturing below 15' (generally, mod. fract.

rec. 2.0/2.0

*note fractures appear at random orientations, are coated with thin iron oxide deposits and generally tight)

20'-22' Moss

rec. 2.0/2.0

22'-24' Moss

rec. 2.0/2.0

bag samp. 23'-24'

24'-26' Moss

rec. 2.0/2.0

(Page 74)

5.3'-28' Claystone desc. (cont.). moist-v.moist, mod. heavy iron staining from 27'-27.5'

26'-28' Moss

rec. 2.0/2.0

28'-30' Moss

rec. 2.0/2.0

28'-150' CLAYSTONE: dark gray; fresh;friable;soft;generally appears massive (fractures infreq. noted). Soil Properties: damp; hard;high plastic (CH);locally silty (CL).

30'-32' Moss

rec. 2.0/2.0

bag samp. 31'-32'

[Note: following log produced after drilling (log of core in ASI trailer]

32' 1/19:1/20

ream hole, set 6"

ID PVC surface casing to 32'

scattered hard,yellowish-brn. claystone nodules, subrounded from 34-35' (nodules appear encased in undisturbed claystone no apparent shearing or disturb. locally hard, cemented (carb.), caliche zone; includes some nods.

1/27/95 > 2/2/95

32'-150' H.X. core

clear water drill fluid

core loss, 32'-33.5'

36.6-38.5 ASI

driller noted 30 gallons

fluid loss @ 55'

core loss, 42'-43.5' ASI

/clasts up to 0.5", subangular to rounded suggesting (locally) a breccia texture, from 38.5-39.5' (zone includes a 1" to 2" thick, hard, cemented band showing horizontal bedding/lamination. apparent breccia is possibly in part or wholly due to drill action (appears natural). log continued on page 86.

(Page 86) 57194 (cont.)
28-150' claystone (cont.)
38.5'-39.5' caliche rich zone;
possibly brecciated/disturbed
(described on page 74); *note: zone
has strong reaction to weak HCL
acid. Note: strong HCL reaction/
caliche also from 36.4-36.6
(interval immediately above zone
of core loss, from 36.6-38.5'
Therefore: zone of caliche possibly
extends from 36.4-39.5'.

yellowish-brn., hard claystone
nodule at 40.5' (within the
disturb cs)

[note: driller reported
30 gallons water loss at
55'- no unusual fract. or
lithology changes noted at
that depth]

Several hard, subang., iron stn.
nodules, up to .25" at 48.5'
cs nodules encasing clay appear
undisturbed but subhorizontal
surface could be natural shear
surface.

yellowish brn., hard cs nodules @
52' (occur at 30°, slickensided
surface, possible shear, where dark
brn.-gray clay occurs along olive-
gray clay-v. subtle color
difference along shear (?).

(Page 87) 57194 (cont.)
28'-150' claystone descr. (cont.) core loss from 72'-73.5'
core appears softer, shows numerous
shear surfaces at various
orientations from 73.5' to 74.5'
(possibly mech.)

black carbonaceous from 74.5' to
75.5' (lignite/coal)
logged to 84.5'

below Woman Creek elevation

Hole completed at TD @ 150'
2/2/95

(Page 75) Monday 1/23/95

On-site at 8:15 AM. Completion of casing installation in 57194
under way. Rig won't get onto decon. pad until early afternoon.
left site for Broomfield at 8:35 AM. Returned to RFP at 2:10 PM.
Adjusted boring locations at *96, *90 (due to biology objections)

and plugged #71294 (within 1994 slide). Because of moving *96 to the south, we will eliminate *83 and move it to *71 location, for additional hole to be drilled at that location (for sampling the shallow slide plane and installing a shallow well [as per request of Mark Wood]. Left RFP at 4:05 PM. Returned to Broomfield. No rig decon. until tomorrow AM.

(Page 76) Tuesday 1/24/95

On-site at 8:30 AM. Continued mapping of landfill area. Commenced drilling 57694 at 2:20 PM. Rig down at 2' deep, at 2:25 PM. Left RFP at 3:30 PM, for Broomfield.

(Page 77) Boring 57694

Location: 30' west of well 59893 (within limits of apparent slide on 1951, 1937 air photo's).

Mobile B-57

Boyles Brothers

Advanced hole with 3.25" ID Hollow Stem Augers

3" Shelby Tubes

Moss Sampling

Cal Mod drive sampling

water not encountered

drilled 1/24/95, 1/27/95

TD @ 36.5'

(Page 78) Boring 57694

COLLUVIUM/SLIDE

0'-3' SANDY CLAY with GRAVEL

(CL-CH): dark yellowish-brn.;

moist;appears stiff-v.stiff;

[broken, crumbled texture below

1' (from 1' to 2') probably mech.]

3' CLAYSTONE: interface sampled in

Shelby tube. Tip: Mod. weathered

claystone;dry;some roots (from

Paul Jordan Log)

Mod. weathered, brnish-gray,dry

claystone;dry roots.

Tip: Mod. weathered claystone;dry;

iron stained (from P. Jordan log)

Cal Mod Sample Description: dark

gray claystone w/ notable vertical

fractures and iron staining;

dry to moist.

0'-2' Moss

rec. 2.0/2.0

rig down @ 2:25 PM.

resume drilling at 10:30

1/27/95

Mark Yaskanin arrived at

drill site at 11:30. Hole

had been advanced to 14'.

2'-4' Push Shelby

rec. 1.9-2.0

4'-6' Cal Mod

11/15/18/19

rec. 1.3/2.0

6-8' push Shelby

rec. 2.0/2.0

8'-10' push Shelby

rec. 2.0/2.0

10-11.5' Cal Mod

16/31/48; rec. 1.5/1.5

11.5-12 drill out

12-14' push Shelby

(Page 79) Mark Yaskanin Log

14-14.5' severely weathered

claystone;yellowish-brn.;moist

(grading to moist and softer gray)

Claystone at 15' with organics

14'-16' Cal Mod

9/16/21/42

rec.2.0/2.0

bag samp. 15'

16-17.3' Cal Mod

grading to mod. weathered gray claystone with organics and iron staining.

Continued mod. weathered dry claystone with iron staining; v. dense; occ. iron concretions; org. at 18.1'.

Mod. weathered gray claystone with iron staining. iron staining varies with depth showing var. gray to brownish gray samples. Driller noted hard drilling. Samples dry to moist (typ. moist)

32.5' fresh claystone: dark gray, no more iron staining, dry to moist. TD @ 36.5'

17/44/50 for 0.3
Drill out to 17.5'
17.5-18.3' Cal Mod
50/50 for 0.3
18.3-18.5 Drill out
18.5-20.5' Moss
20.5-22.5' Moss
22.5'-24.5' Moss
24.5'-26.5' Moss
26.5'-28.5' Moss
28.5'-30.5' Moss
30.5'-32.5' Moss
32.5'-34.5' Moss
34.5'-36.5' Moss

Rec. 2.0/2.0

(Page 88) Boring 57694 relogged page 78 see above for sampling
COLLUVIUM/SLIDE

0'-3' SANDY CLAY with GRAVEL (GC): dark yellowish-brn.; moist; stiff -v. stiff.

0'-2' Moss; rec. 2.0/2.0
2' 1/24:1/27
2'-4' push Shelby
rec. 1.9/2.0
4'-6' Cal Mod
11/15/18/19

ARAPAHOE/SLIDE(?)

3'-14.5' CLAYSTONE: yellowish-brn. gray; mottled orange; severely to mod. weathered; plastic-friable; soft; variably fractured. rootlets to 5'. Soil Properties: damp; v. stiff-hard; mod.-highly plastic (CL-CH).

mod. weathered w/ near vertical, heavily iron stained fracture (shows slickensides) from 10'-11.5' CLAYSTONE: yellowish-brn., mottled orange, has crushed appearance, w/ angular claystone fragments (fragment surfaces showing slickensides) from 14' -14.5'

rec. 1.3/2.0
6'-8' push Shelby
rec. 2.0/2.0
8'-10' push Shelby
rec. 2.0/2.0
10'-11.5' Cal Mod
16/31/48; rec. 1.5/1:5
drill out to 12'
12'-14' push Shelby
rec. 2.0/2.0
14'-16' Cal Mod
9/16/21/42; rec. 2.0/2.0
bag samp. 15.1'-15.5'
pp on material
at 15.5' (bag)
=1.5 tsf

ARAPAHOE FORMATION

14.5'-15.5' CLAYSTONE/CLAY (CH):

(Page 89) 57694 (cont.)

14.5'-15.5' CLAYSTONE/CLAY (CH): dark brown-gray; v. moist; stiff; high plastic. Rock Properties: severely weathered; plastic; soft*. .25' wide zone of slickensides, iron stained, (hor. up to 20⁰) at 14.5' (immediately below

*includes some black carbonaceous material.

contact w/ crushed looking
 claystone above) 32.3' CLAYSTONE:
 gray-brn.; mod. weathered; plastic
 -friable; soft; mostly massive,
 blocky texture*. Soil Properties:
 damp; hard; mod.-highly plastic
 (CL-CH). occ. black, carb.
 material.
 yellowish-brn., gray, mottled
 orange below 16'.
 32.3'-36.5' CLAYSTONE: dark gray
 -brn.; fresh; friable; soft. Soil
 Properties: damp; hard; mod.-highly
 plastic (CL-CH).

also, occ. v. narrow
 iron stained frags., some
 vertical.
 *locally laminated (v. thin
 bedded, w/sub-horizontal,
 iron stained surfaces)
 16'-17.3' Cal Mod
 17/44/50/4"; refusal
 drill out to 17.5'
 17.5'-18.3' Cal Mod
 50/50/4" refusal
 drill out to 18.5'
 18.5'-20.5' Moss
 20.5'-36.5' Continuous Moss
 (2' advances)
 rec. 2.0/2.0, all samples
 except 34-34.5' no rec./ASI

(Page 80) Wednesday 1/25/95

On-site at 8:00 AM. Rig needs to be taken off-site for repairs;
 drilling on 57694 will probably resume next Monday. Recovered and
 logged initial 0'-2' sample for 57694. Continued mapping of
 landfill area. Left site at 12:30 PM. Returned to Broomfield.

(Page 81) Boring 59094

Location: New Woman Creek; 30' east of well 5786.
 Mobile B-57
 Boyles Brothers
 Advanced hole with 3.25" ID Hollow Stem Augers
 3" Shelby Tubes
 Moss Sampling
 Cal Mod drive sampling
 water measured at 12.4' after drilling
 drilled 1/30/95,
 TD @ 17'

(Page 82) Boring 59094 (relogged on page 90 & 91)

COLLUVIUM

0-2.3' SANDY, CLAYEY GRAVEL (GC):
 orange-brn.; moist; occ. cobble
 (hard drilling); includes some clay
 (CL-CH); appears soft. Possibly
 FILL or SLIDE..
 2.3-3.3' SANDY-SILT/SILTSTONE:
 yellowish-brn; sand/silt; moist;
 dense; grading to silty; more
 sandstone at 3.3'; severely
 weathered siltstone grading to
 silty-fine sandstone.
 3.3-3.6' SILTY SAND/f. grained
 SANDSTONE: brnish-gray, silty sand;
 moist; dense;
 f. grained SILTY SANDSTONE;

0-2' Moss
 rec. 1.9/2.0
 2-4' Cal Mod
 28/22/20/24
 rec. 2.0/2.0
 4-5.2' push Shelby
 rec. 1.2/1.2
 crimped end of base
 5.2-6.0' Cal Mod
 34/50 @ 3'
 rec. 0.8/0.8
 *Note: presence of
 relatively undisturbed
 claystone over alluvium
 suggests possible slide
 material, 0-4.7'

severely weathered; grading to claystone.

3.6-4.7' CLAYSTONE: severely to mod.- weathered; claystone; brownish-gray w/iron staining; mottled; moist.

4.7-5.5' GRAVELLY, CLAYEY SAND - SANDY, CLAYEY GRAVEL (SC-GC) (COLLUVIUM?): tip of Shelby tube contained alluvium w/ rootlets; dark-brn.; moist;

(Page 83) Boring 59094 (cont')

ALLUVIUM

5.5-12' SANDY, CLAYEY GRAVEL (GC): orange-brn.; moist; wet below 11'; f.-crs. gravel, cobbles.

ARAPAHOE FORMATION

12-17' CLAYSTONE (CL-CH): yellowish-brn., mottled orange; highly-mod. weathered; mod. weathered below 13'; plastic -friable; soft. Soil Properties: hard; damp; mod.-highly plastic; predominantly gray, occ. orange staining below 15'.

(also, possibly sloughed-in detrital block of claystone) not as likely due to creek floor.

Very hard drilling at 6' (cobble) to 7'

7.0-7.2' Cal Mod
50 for 2"
no rec.
attempted to drill
out of cobbles; advanced
hole to 8' and
stopped because hole
could not be advanced
through cobble/boulder
Moved rig back 2.5'
and started new hole.
drill to 11' without
sampling 11-13' Moss
rec. 1.0/2.0
13'-14.8' push Shelby
rec. 1.8/1.8
drill out to 15'
15'-15.8' Cal Mod
39/50/4"; refusal
15.8'; rec. 0.8/0.8
drill out to 16'
16'-17' Cal Mod
45/50/6" refused at 17'
Terminate at 17'.

(Page 90) Boring 59094 (relogged core)

COLLUVIUM/SLIDE

0'-2.3' SANDY, CLAYEY GRAVEL (GC): orange-brn.; moist; includes some pockets of greenish-gray; v. moist;
CLAY (CL-CH): clay appears soft.

0'-2' Moss
rec. 1.9-2.0
2'-4' Cal Mod
28/22/20/24
rec. 2.0/2.0
4'-5.2' Push Shelby
rec. 1.2/1.2; crimped

BEDROCK/SLIDE

2.3'-3' SANDY SILTSTONE: yellowish-brn., mottled orange; mod.-highly weathered; friable; soft. Soil Properties: damp; med.-dense.
3-4.5' CLAYSTONE (ML): gray-brn.; mod.-highly weathered; plastic-friable; soft. Soil Properties: moist; v. stiff; (CL-CH). Includes some sandy-silt laminae.

end of tube
(Note: bedrock material from 2.3'-4.5' appears mostly intact/unmixed shows some recognizable, stained fractures & rock structure): however, does appear somewhat disturbed
Presence of this material

over alluvium suggests
possible slide, 0'-4.7'

(Page 91) relogged core (59094)

COLLUVIUM

4.5'-5.5' GRAVELY, CLAYEY SAND-
SANDY, CLAYEY GRAVEL (SC-GC): dark-
brn.; moist; rootlets; (possibly
organic stained, surficial
alluvium).

ALLUVIUM

5.5'-12' SANDY, CLAYEY GRAVEL (GC):
orange-brn.; moist; wet below 11'; f.
-crs. gravel, cobbles.

ARAPAHOE FORMATION

12'-17' CLAYSTONE: yellowish-brn.,
mottled orange; highly-mod.
weathered below 13'; plastic to
friable; soft. Soil Properties:
hard; damp; mod.-highly plastic
(CL-CH); predominantly gray, occ.
orange staining below 15'.

Hole bottom at 17'
grout backfill

5.2'-6' Cal Mod
34/50/3"; rec. 0.8/0.8
v. hard drilling
5.6'-7' cobbles
7'-7.2' Cal Mod
50 for 2"; no rec.
attempt to drill
out below cobbles;
advance augers to 8'
auger refusal at 8'
move hole 2.5' east
drill to 11' w/out samp.
11'-13' Moss
rec. 1.0/2.0
13'-14.8' push Shelby
rec. 1.8/1.8
drill out to 15'
15'-15.8' Cal Mod
39/50/4"; rec. 0.8/0.8
drill out to 16'
16'-17' Cal Mod
45/50/6"; rec. 1.0/1.0
Terminate at 17'

(Page 84) Monday 1/30/95

On site at RFP at 1:00 PM. Replaced Mark Yaskanin logging 59094,
at approx. 11' deep. [Note: 57694 was drilled and grout backfilled
on 1/27/95, Friday; Mark Yaskanin logging.] Completed 59094 at 17'
TD, at 3:00 PM. Checked core from 57694 and 57194 (below 32').
Left RFP at 4:55 PM.

(Page 85) Tuesday 1/31/95

On-site at 9:00 AM. Made geotechnical logs for borings 57194
(deeper, cored portion from 32' to 84.5') and relogged 57694 from
core/sample boxes in ASI trailer (hole was initially logged by Mark
Yaskanin on 1/27/95). Checked core from 38'-40' in 57194 with Fred
Grigsby, at ASI trailer. Discussed results of drilling work to
date. Left site at 5:05 PM.

(Page 92) Wednesday 2/1/95

On-site at 8:20 AM. Dropped off unianalysis samples at Med.
Building. Relogged 59094 in ASI trailer. Commenced drilling 71294
at TD at 34.3', at 2:15 PM. Left RFP for Broomfield at 3:00 PM.

(Page 93) Boring 71294

Location: Within "1994 USGS slide" east of east end of landfill,

south of SID road.
Mobile B-57
Boyles Brothers
Advanced hole with 3.25" ID Hollow Stem Augers
3" Shelby Tubes
Moss Sampling
Cal Mod drive sampling
water perched at 28' (wet sample from 28'-28.2'
drilled 2/1/95
TD @ 34.3'

(Page 94) Boring 71294

COLLUVIUM/SLIDE

0'-1' GRAVELLY LEAN CLAY (CL):	0'-2' Moss
dark brn.;moist;mod. plastic;grass	rec. 2.0/2.0
roots to .3'.	2'-4' Cal Mod
1'-5' SANDY CLAY with GRAVEL (CL):	24/28/27/26
yellowish-brn., mod. brown;damp;	rec. 2.0/2.0
v.stiff;occ.claystone fragments;	4'-5.8' Cal Mod
occ. rootlets;gravels to 1"	16/27/41/50/3"
4.5-5' highly weathered claystone.	rec. 1.1/1.8
claystone smeared along 60°,	cobble (rough drilling)
slickensided surface against	at 5.8'
colluvium, at 5'-5.1'	drill out to 6'
5'-7.2' SANDY, CLAYEY GRAVEL (GC):	6' to 8' Cal Mod
orange-brn.;moist;med.dense;f.	25/27/38/32
-crs. gravel;occ. cobbles.	rec.2.0/2.0
	*Note: 6'-8' Cal Mod
	retain bag samples
	6'-7.2'

ARAPAHOE FORMATION

7.2'-30.5' CLAYSTONE: gray,	7.2'-8' Claystone
yellowish-brn.;mid-highly wthered	10'-12' push Shelby
(var.);plastic-friable;soft;	(cont'. on next page)
closely fractured;abundant iron	
stained fract. surfaces at var.	
orientations.	

(Page 95) 71294 cont'

7.2'-30.5' claystone cont'	10'-12' push Shelby
numerous slickensided surfaces at	rec. 1.7/2.0
various orientations. Soil	push up to 6500#
Properties: damp;v.stiff;highly	slight crimp in tube
plastic (CH). Note: 0.25" thick	bottom
crushed claystone (gough like),	pp=4.5+ at 11.7'
at 20° dip at 7.8' (possible slide	12'-13.3' Cal Mod
base?)	24/45/50/4"
Hard below 10';occ. slickensided	rec. 1.3/1.3
surfaces below 10'; occ. sand-f.	drill out to 13.5'
gravel sized iron concretions,	13.5'-14.4' Cal Mod
occ. carbonaceous material below	30/50/5";rec. 0.9/0.9
10'.	14.5'-15.3' Cal Mod
Predominantly gray, occ. orange	40/50/4";rec. 0.8/0.8
iron staining in ground mass and	drill out to 15.5'
along fractures;generally less	bag sample 13.5'-14.4'

fractured. (mod. fractured) below 15'
Appears intensely fractured; some slickensided polished surfaces; softer. Soil Properties: stiff-v.stiff from 17.5-17.8' (however does not appear disrupted w/ displaced materials

15.5'-17.5' Moss
rec. 2.0/2.0
17.5'-18.3' Cal Mod
27/50/4";rec. 0.8/0.8
drill out to 18.5'
18.5'-20.5' Moss
rec. 2.0/2.0
20.5'-21' Cal Mod
50/6";rec. 0.5/0.5

(Page 96) 71294

7.2'-30.5' Claystone cont'
predominantly yellowish-brn., mottled orange;damp to moist below 22' (22'-30.5')
v. thinly laminated, some slickensides along horiz. surfs;
v. heavy iron staining, from 27'-29';caliche(?) from 27'-27.5')
wet (perched water) from 28'-28.2'
hard;iron cemented from 28.5-28.8'
30.5'-34.3' CLAYSTONE:dark gray; fresh;friable;soft;massive?;some slickensided surfaces, random, observed from 33'-33.5'. Soil Properties:damp;hard;highly plastic (CH).

21'-22' Moss
rec. 1.0/1.0;bag samp
22'-24' Moss
rec. 2.0/2.0
24'-26' Moss
rec. 2.0/2.0
bag samp. 25'-26'
26'-28' Moss
rec. 2.0/2.0
28'-28.8' Moss
rec. 0.8/0.8;(v. hard advance) wet, perched at 28'
28.8'-30.8' Moss
rec. 2.0/2.0
30.8'-32.8' Moss
rec.1.0/2.0
32.8'-34.3' Moss
rec. 1.5/1.5
bag samp. 32.8-34.3'
Terminate at 34.3'.

Hole bottom at 34.3'

(Page 97) Thursday 2/2/95

On-site at 9:00 AM. Logged core from 57594, 0' to 37.3', in core/sample trailer (next to ASI field office). Re-examined/re-interpreted 57094 samples. Inspected recent slides along north slope of N. Walnut Creek, toward east end of RFP. Head scarps expose mod. to severely weathered claystone. Left RFP for Broomfield at 12:40 PM.

(Page 98) Boring 57594

[Note: log of core in boxes-hole drilled late October/early November, 1994] ASI log used to supplement these notes.

COLLUVIUM/SLIDE

0-5' SANDY CLAY (CL):dark-brn.; dry;damp below 2';stiff-v.stiff below 2';occ. roots; some slickensides at 4.5'(possibly mech.); disturbed by center bit near the top of the sample.
5'-6' GRAVELLY, SANDY CLAY (CL): h.yellowish-brn.;moist (ASI);

0-2' Cal Mod
6/15/15/20
rec. 1.0/2.0
2'-4' Cal Mod
14/20/28/42
rec. 1.3/2.0
4'-6' Cal Mod
8/21/30/45
rec. 1.7/2.0

v.stiff.

CLAYSTONE/SLIDE

16'-16.5' CLAYSTONE: gray-brn., yellowish-brn., var. mottled orange;mod.-severely weathered (var.);plastic-friable;soft;occ. displays a breccia-like texture, with claystone frags. (angular) within more weathered matrix; occ. iron concretions. Soil Properties: v.stiff;damp;mod.-high plastic (CL-CH); **see comments on base of slide depth on next page.

6'-8' Cal Mod
10/22/36/50
rec. 1.4/2.0
8'-10' Cal Mod
10/27/24/25
rec. 1.7/2.0
10'-12' Cal Mod
6/10/14/17
rec. 2.0/2.0
12'-14' Cal Mod
6/8/23/21
rec. 1.7/2.0

(Page 99) Boring 57594

6-16.5' Claystone/slide cont'
occ. white prec. (caliche?)
stiff from 10'

Mod.-dark brn.;gravelly clay
(CL-CH) moist;stiff; [buried/
reworked alluvium] from 13.5'
to 13.7'.

orange-brn., SANDY, CLAYEY GRAVEL
to GRAVELLY CLAY (GC-CL): moist;
stiff;[buried reworked colluvium]
from 13.5'-13.7'

orange brown, SANDY, CLAYEY GRAVEL
-GRAVELLY CLAY (GC-CL): moist
stiff;med. dense;subangular
gravels;appears mixed from 13.7'-
14'

wet from 13.9'-14' (ASI) possible
base of slide see below at 16.5'
Claystone, as above 13.5'from 14'
to 16' (predominantly mod.
weathered, w/ obvious coherent rock
structure, ie, blocky cs texture)
yellowish-brn.;moist;stiff;GRAVELLY
CLAY (CL-CH) [mixed claystone
gravel] from 16'-16.5'* (possible
slough-if so, then base of slide
at 14')

14'-16' Cal Mod
6/12/16/28
rec. 2.0/2.0
16'-18' Cal Mod
4/12/22/45
rec. 2.0/2.0
18'-20' Cal Mod
5/16/34/50
rec.2.0/2.0
20'-24' No sampl.
(augering 24'-24.9'
HX core; no recovery.
24.9'-29.9' HX core
rec. 3.1-5.0

ARAPAHOE FORMATION

16.5'-19.8' CLAYSTONE: gray-

(Page 100) boring 57594 Geotech notes on ASI deep MW core; drive samples.

16.5'-19.8' claystone cont'.
brown, mottled orange;mod.
weathered;plastic-friable;soft;mod

to closely fractured;(iron stained surfaces);several vertical fractures from 18'-20'.
19.8'-104.9' (observed/logged by RH to 37.3') CLAYSTONE: dark gray; fresh;friable;soft.

Total Depth 104.9'
Well installed by ASI

(Page 101) Friday 2/3/95
On-site at 8:55 AM. Crew preparing to drill 59694. Commence drilling 59694 at 11:15 AM. Completed drilling at 1:30 PM. Installed well. Left RFP at 3:00 PM.

(Page 102) Boring 59694.
Location: 20' north of SID, toward west end of landfill; just south of "west slide" toe.
Mobile B-57
Boyles Brothers
Advanced hole with 3.25" ID Hollow Stem Augers
3" Shelby Tubes
Moss Sampling
Cal Mod drive sampling
free water (in hole) not encountered; wet soil (traces of free water in sample. Observed from 10'-15.5'.
drilled 2/3/95
Install Well 2/3/95:
20'-18': Bentonite Pellets
18'-14': 16/40 sand
4'-2': Bentonite Pellets
2'-0': grout bentonite
18'-16': 2" PVC blank (sump)
16'-6': 2" slotted PVC (.010")
6': surface blank PVC

(Page 103) Boring 59694

FILL

0'-1.8' GRAVELLY, SANDY CLAY (CL):	0'-2' Moss
dark brn.;moist;roots to 1'.	rec. 2.0/2.0
1.8'-13' SANDY, CLAYEY GRAVEL (GC):	2'-2.8' Cal Mod
orange-brn., mod. brn.; damp;dense;drill out to 3'	rec. 0.8/0.8
f.-crs. sand, gravel; occ. roots.	3'-5' Cal Mod
moist below 4'	35/65/48/38;bag samp.
mixed gray, orange-brn. below 5.5'	3'-4'; rec. 1.6/2.0
med. dense (clay matrix appears	5'-7' Cal Mod
soft-firm) from 6'-12';	21/32/25/16
v.moist from 6'-10'	rec. 2.0/2.0
possible mixed colluvium/slide?	7'-9' push Shelby
from 11'-13'	rec. 2.0/2.0
wet below 10'	push up to 4000#
sandy clay with gravel (CL), stiff	bottom 0.1'dented
(? appears softer) from 11'-11.7'	9'-11' Cal Mod
loose from 12'-13'	6/13/19/16

COLLUVIUM/SLIDE

13'-15.5' CLAYEY SAND with GRAVEL:
(derived from the Rocky Flats
Alluvium); orange-brn.; wet; loose;
severely weathered Claystone (?)

SLIDE/GOUGE ? (CL)

15.5'-16' LEAN SILTY CLAY:
yellowish brn., mottled orange/
gray; v. moist-wet; appears soft
(sample disturbed by rock driven
through interval-see comments
regarding blows at right).
Possibly slide/gouge zone

(Page 104) Boring 59694

abrupt contact between silty clay
and mod. weathered claystone at
16'.

ARAPAHOE FORMATION

16'-18' CLAYSTONE: dark gray, faint
occ. orange iron staining; mod. to
slightly weathered; friable; soft.
Soil Properties: damp; hard; (CH).
18'-20' CLAYSTONE: dark gray; fresh;
friable; soft. Soil Properties:
damp; hard; (CH).

Bottom of Hole at 20'

Install well 2/3/95
(details on page 102)

**Boring Summary

0'-13' (?) FILL: mostly (GC);
possibly mixed Colluvium/Slide
from 11'-13'
13'-15.5' COLLUVIUM/SLIDE (SC):
derived from Rocky Flats Alluvium;
(probably slid to this position
considering sharpness of contact
with claystone at 16')
15.5'-16' BASE OF SLIDE GOUGE
possibly consisting of severely
weathered cs?)
16'-18' CLAYSTONE: mod.-slightly
weathered
18'-20' CLAYSTONE: fresh

rec. 1.8/2.0
11'-13' Cal Mod
9/14/10/9; bag samp.
12'-13'; rec. 1.8/2.0
13'-15' push Shelby
easy push; rec. 1.1/2.0
15'-17' Cal Mod
*13/16/19/26
rec. 2.0/2.0
sample disturbed (pushing
a rock elevated blows?)
from 13'-14'

17'-17.9' Cal Mod
23/50/5"; rec. 0.9/0.9
drill out to 18'
18'-20' Moss
rec. 1.8/2.0

v. hard to advance
[Note: retained bulk
sample of fill cuttings
0-15' (Bucket)]

Terminate at 20'.

(Page 105) Monday 2/6/95

On-site at 8:50 AM. Crew setting up on 56894. Commence drilling at

10:05 AM. Completed hole at 12:20 PM, at 33' TD. Grout Backfill 56894. Commence drilling 58394 at 2:30 PM. Complete 58394 at 4:30 PM; did not succeed in sampling slide contact. Slow frisk-out due to high alpha reading on Allison (ASI). Dean says this is probably due to radon. Left site at 5:35 PM.

(Page 106) Boring 56894

Location: 60' SW of borehole 50892; approximately mid-slope above SID, toward east end of landfill.

Mobile B-57

Boyles Brothers

Advanced hole with 3.25" ID Hollow Stem Augers

3" Shelby Tubes

Moss Sampling

Cal Mod drive sampling

water not encountered

drilled 2/6/95

TD at 33'

(Page 107) Boring 56894

COLLUVIUM (possibly FILL)

0'-0.7' GRAVELLY, SANDY CLAY (CL):	rec. 2.0/2.0
dark brn.; damp; roots.	2'-3.4' Cal Mod
0.7'-6.3' SANDY, CLAYEY GRAVEL	27/37/50/5"
(GC): yellowish-brn., mottled	rec. 1.4/1.4
orange; damp; dense; f.-crs. gravel,	drill out to 3.5'
occ. cobbles.	3.5'-5' Cal Mod
6.3'-6.5' SANDY CLAY (CL): orange-	40/46/50/6"; bag samp.
brn.; moist; f.-crs. sand; some	3.5-4.6'; rec. 1.1/1.5
gravel.	5-5.4' Cal Mod

ARAPAHOE FORMATION

6.5'-7.7' SILTSTONE/SANDY CLAYEY	50/5" rec. 0/0.4
SILT (ML): yellowish-brn., mottled	drill out to 5.5'
orange; damp; stiff-v. stiff(?);	5.5'-7.5' Moss
v. fine sand. Rock Properties:	rec. 1.0/2.0
severely weathered; plastic; soft.	7.5'-9.5' Cal Mod
7.7'-10.5' CLAYSTONE/FAT CLAY (CH):	10/19/25/33
dark gray-brn.; moist; stiff-v. stiff	rec. 2.0/2.0
Rock Properties: severely	bag samp. 8.5'-9'
weathered; plastic; soft. Includes	pp=1.8 tsf @ 8.5
some carbonaceous material.	9.5'-11.5' push Shelby
	push to 4000# to 10.5'
	v. hard push, up to 8500#
	from 10.5-11.5'
	rec. 1.8/2.0

(Page 108) 56894 (cont')

10.5-30.6' Claystone:	11.5'-13' Cal Mod
yellowish-brn, mottled orange,	31/38/50/6"; rec. 1.5/1.5
gray; mod. weathered; plastic to	13'-15' Moss
friable; soft; occ. iron	rec. 2.0/2.0
concretions; numerous v. fine	bag sample 14'-15'
silty sand-sandy silt (gray)	15'-17' Moss
laminae/pockets**. Soil	rec. 2.0/2.0
Properties: damp; hard; mod.-high	17'-19' Moss

plastic (CL-CH). Generally thinly laminated; mod. fractured (numerous tight, iron stained bedding surfaces, fractures). Includes some carbonaceous material. damp to moist, locally moist below 21'	rec. 2.0/2.0 19'-21' Moss rec. 2.0/2.0 bag sample 20-21' 21'-23' Moss rec. 2.0/2.0 23'-25' Moss rec. 2.0/2.0 25'-27' Moss rec. 2.0/2.0 27'-27.7' Push Shelby push required 8500# rec. 0.7/0.7 badly dented bottom 3" 27.7-29' Moss rec. 1.3/1.3
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(Page 109) Boring 56894 (cont.) 10.5'-30.6' Claystone (cont') moist from 30.5'-33' Claystone: dark gray; fresh; friable; soft; thinly laminated (horizontal); w/ v. thin interbeds (up to 1/16") of v. fine silty sand-sandy silt. Soil Properties: damp (silty sand laminae are dry); hard; mod.-highly plastic; (CL-CH).	29'-31' Moss rec. 2.0/2.0 31'-33' Moss rec. 2.0/2.0 bag samp. 32'-33'
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TD at 33'
Grout Backfill

Terminate at 33'

(Page 110) Boring 58394
Location 3' SE of 57194 (adjacent hole to sample slide contact at 4', and install shallow well).
Mobile B-57
Boyles Brothers
Advanced hole with 3.25" ID Hollow Stem Augers
3" Shelby Tubes
Moss Sampling
Cal Mod drive sampling
water not encountered
drilled 2/6/95
TD at 9.5'
Install Well, 2/7/95
2" blank PVC sump, 5.5'-7.5'
2" 0.010" slotted PVC screen, 3.5'-5.5'
2" blank PVC, 3.5' to surface
Bentonite Pellets, 7.5'-8.5'
Cave 8.5'-9.5'
Sand #16-40, 7.5'-3'
Bentonite Pellets, 3' to surface

(Page 111) Boring 58394 (cont')

WASTE FILL/SLIDE

0'-4' SANDY, CLAYEY GRAVEL (GC):
orange-brn., mod. brn, dark brn.
(mixed); damp; moist; med. dense;
some cobbles.
cobble, v. rough drilling, from
3'-3.3'.
slide/contact between FILL and
CLAYSTONE at 4'; (based on
57194).

ARAPAHOE FORMATION

4'-6.3' CLAYSTONE: dark gray,
mottled orange; highly to
severely weathered; friable;
plastic; soft.
6.3'-9.5' CLAYSTONE: dark gray,
mottled orange; mod. weathered;
friable; soft; mod.-closely
fractured.
vertical iron-stained fracture
from 7.5'-9'.

0-1.4' Moss
rec. 1.0/1.4
bag samp.
1.4-2.9' Cal Mod
15/20/38
rec. 1.4/1.5 bag samp.
drill out to 3.3'
3.3'-3.7' push Shelby
v. hard push (up to 8000#)
rec. 0/0.4
trashed tube on cobbles
drill out to 3.8'
3.8'-5.4' Push Shelby
push at 4000# to 5.4'
stopped at 5.4'
rec. 0.1/1.6
samp. disturbed
tube bottom trashed
prob. pushing gravels
through contact
drill out to 5.5'
5.5'-7.5' Cal Mod
9/20/37/44.
rec. 1.3/2.0
bag sample
7.5'-9.5' Cal Mod
6/20/31; rec. 1.8/2.0
bag sample
Terminate at 9.5'

TD at 9.5'.
Install Well
see pg. 110 for details

(Page 112) Tuesday 2/7/95

On-site at 9:00 AM. Boring 58394 drill crew installing shallow well. Other drill crew preparing to drill 56794. Commence drilling 56794 at 10:15 AM. Complete 56794, at 25' TD, at 12:15 PM. Left site for Broomfield at 12:45 PM.

(Page 113) Boring 56794

Location: about mid-slope above SID, at east end of landfill, approx. 10' west of well 58494.

Mobile B-57

Boyles Brothers

Advanced hole with 3.25" ID Hollow Stem Augers

3" Shelby Tubes

Moss Sampling

Cal Mod drive sampling

water not encountered (v. moist to wet from 11'-13')

drilled 2/7/95

TD at 25'

(Page 114) Boring 56794 (cont.)

COLLUVIUM - possible FILL

0'-2' SANDY, CLAYEY GRAVEL (GC):
mod.-brn., orange-brn.; moist; med.
dense; f.-crs. gravel; some cobbles.

COLLUVIUM

2'-11' SANDY CLAY (CL): dark-brn.;
moist; v. stiff; minor f. gravel; occ.
roots; gray brn.; some orange
mottling below 4'.

stiff below 5'.

heavy orange mottling (iron
stained) below 8'.

11'-13' SANDY, CLAYEY GRAVEL (GC):
mottled gray, orange; v. moist-wet;
med. dense; f.-crs. gravel; approx
1" thick-greenish gray clay layer
appears firm; (CL-CH): at 11.8'.

ARAPAHOE FORMATION

13'-14.5' CLAYSTONE/FAT CLAY

0'-2' Moss

rec. 1.1/2.0

2'-4' Cal Mod

23/22/33/29

bag samp. 2'-3.5'

rec. 1.5-2.0

4'-6' Cal Mod

13/19/15/16

rec. 2.0/2.0

6'-8' push Shelby

push up to 6000#

rec. 1.4/2.0

pp=2.5-3.25 tsf @ 7.4'

8'-10' Cal Mod

10/12/17/15

rec. 2.0/2.0

bag samp. 9'-10'

10'-12' Cal Mod

7/10/14/14

rec. 2.0/2.0

12'-14' push Shelby

push up to 4000#

note: harder push @ 13'

rec. 1.9-2.0

pp=1.5 tsf @ 13.9'

(Page 115) Boring 56794

13'-14.5' CLAYSTONE/FAT CLAY

CLAY (ch): gray brn.; very moist;
stiff. Rock Properties: severely
weathered; plastic; soft. Includes
some black carbonaceous material.
v. stiff; mottled orange; from
approx. 14-14.5'

14.5'-15.5' CLAYSTONE: gray-brn.,
var. orange mottling; highly
weathered; plastic; soft. Soil
Properties: moist-v. moist; v. stiff
to hard; highly plastic (CH).

15.5'-22' CLAYSTONE: gray, some
orange Fe-staining, usually along
fractures; mod. weathered; friable;
soft; mod.-closely fractured; occ.
shows horizontal bedding surfaces;
(iron stained, tight). Soil

Properties: damp; hard; CH
gray-brn., yellowish-brn., mottled
orange from 17'-21';
gray, some orange mottling from
21'-22'

14'-16' Cal Mod

15/28/35/50

rec. 1.1/2.0

16'-16.8' Cal Mod

35/50/4"

rec. 0.8/0.8

drill out to 17'

17'-19' Moss

rec. 2.0/2.0

19'-21' Moss

rec. 2.0/2.0

bag samp. 20'-21'

21'-23' Moss

rec. 1.4/2.0

(Page 116) 56794 cont.

22'-25' CLAYSTONE: dark gray;
fresh; friable; soft; occ. v. thin
laminae of silt; h. gray

23'-25' Moss
rec. 1.3/2.0

TD @ 25'
Grout Backfill

Terminate @ 25'

(Page 117) Wednesday 2/8/95

On-site at 8:10 AM. Crew setting up rig on 59194. Commence drilling at 9:40 AM. Complete 59194 at 1:00 PM, at 46' TD. (Well installed 2/9/95). Other crew preparing to drill 71494, at 57194/58394 location. 71494 will be advanced to 45', to screen fractured/caliche zone noted at 39' in 57194. Commenced drilling 71494 at 3:45 PM. Attempted to sample the slide contact at 4' deep (as encountered in 57194) via Shelby tube. Recovered tube of sample from 4'-5.5' (possibly slide contact in tube). Note: 71494 is 4' east of 58394. Left rig at 4:40 PM, after recovering Shelby Tube from 4'-5.5'. Left RFP at 5:30 PM.

(Page 118) Boring 59194

Location: Edge of flats, at central part of landfill (just above 59794/71194).

Mobile B-57

Boyles Brothers

Advanced hole with 3.25" ID Hollow Stem Augers

3" Shelby Tubes

Moss Sampling

Cal Mod drive sampling

water (wet soil, sampler dry) from 30'-33.3' (perched on cs)
drilled 2/8/95

TD at 46'

Installed well 2/9/95:

Bentonite Pellets, 46'-38'

Sand #16-40, 24'-38'

Bentonite Pellets, 21'-24'

Bentonite Grout, 0'-21'

2" solid PVC sump, 36'-38'

2" 0.010" slotted PVC screen, 26'-36'

2" blank PVC, 0'-26'

(Page 119) 59194 cont.

FILL

0'-10.5' SANDY, CLAYEY GRAVEL &
COBBLES (GC): orange-brn., mod.
brn.; moist; dry-damp below 2'; med.
dense(?) [gravels and cobbles
too coarse for accurate PR]
graphite at 4.8'
graphite at 6'
solid plastic clear chunk in
cuttings from 8' ?
mostly dark brn., some black
(graphite) below 6'

0'-2' Moss
rec. 0.9/2.0
2'-4' Moss
rec. 0.8/2.0
rough drilling-8'
4'-6' Moss
rec. 0.8'/2.0'
6'-6.9' Cal Mod
26/50/5"; rec. 0.1/0.9
6.9'-8' Moss
rec. 1.1/1.1
8'-10' Moss

v.moist to wet, gray SANDY
CLAYEY GRAVEL, some glass at 9'
v.moist-wet, gray-brn. (GC):
w/ glass, from 10'-10.5'

ROCKY FLATS ALLUVIUM

10.5'-33.3' SANDY, CLAYEY GRAVEL
(GC): orange-brn., occ. greenish
gray (clay matrix); moist; med.
dense-dense; f.-crs. sand & gravel,
subrounded-subangular; occ. cobbles

rec. 1.1/2.0
v. easy smooth
advance, 8'-11'
10'-12' Moss
rec. 1.0/2.0
12'-14' Moss
rec. 2.0/2.0
bag samp., 13'-14'
14'-15' Cal Mod
27/50/6"; rec. 1.0/1.0
15'/16' Moss
rec. 1.0/1.0

(Page 120) 59194 cont.

10.5'-33.3' SANDY, CLAYEY GRAVEL
sandy clay (CL), appears v.stiff;
from 17'-17.3'
f.clayey sand (SC) from 19.8'-
20.5'

16'-18' Moss
rec. 1.5/2.0
attempt Cal Mod
at 18', bouncing
18'-20' Moss; bag samp.
18.5-20'; rec. 2.0/2.0
41/50/5"; rec. 0.9/0.9
20.9'-22' Moss
rec. 1.1/1.1
22'-24' Moss
rec. 2.0/2.0
24'-26' Moss
rec. 0.4/2.0
26'-28' Moss
rec. 2.0/2.0
28'-30' Moss
rec. 2.0/2.0
trip out augers
Moss won't latch
30'-31.9' Cal Mod
21/29/27/50/5";
rec. 1.4/1.9
drill out to 32'

LEAN CLAY (CL): yellowish-brn.,
mottled orange, gray; moist stiff;
(pp=1.5 tsf at 27') from 26'-27.5'

v.moist below 29'

wet below 30'

(Page 121)

10.5'-33.3' SANDY, CLAYEY GRAVEL
cont.
contact with claystone appears
depositional (crs. gravels a top
cs) cs appears undisturbed.

ARAPAHOE FORMATION

33.3'-36' CLAYSTONE: yellowish-
brn., gray-mottled orange; mod.-
highly weathered; plastic-friable;
soft; closely fractured; occ.
laminated approx. horiz..
Soil Properties: damp-moist; hard;

32'-34' Moss
rec. 2.0/2.0
34'-35.1' push Shelby
refusal @ 35.1' (9000#)
rec. 1.1/1.1 bottom 2" bent
35.1'-36' Moss
rec. 0.9/0.9
36'-38' Moss
bag samp. 37'-38'
rec. 2.0/2.0
38'-40' Moss
rec. 2.0/2.0
40'-42' Moss

CH.
36'-44' CLAYSTONE:dark gray, occ.
gray-brn.,occ. orange iron
staining (in ground mass and
along fractures); mod. weathered;
friable;soft;shows some horiz.
bedding/lamination (iron stained/
tight surfaces). Soil Properties:
damp;hard;CH.
44'-46' CLAYSTONE:black;fresh;
friable;soft. Soil Properties:
damp;hard;CH.

rec. 0.7/2.0
42'-44' Moss
rec. 2.0/2.0
44'-46' Moss
rec. 1.4/2.0

TD at 46'
Installed well 2/9/95
(details on page 118)

Terminate @ 46'

(Page 122) Boring 71494
[Drilled 4' east of 58394]

FILL

0'-4' sandy, clayey gravel

ARAPAHOE FORMATION

4'-5.5'+ CLAYSTONE: mod.
weathered claystone, mod. gray;
friable;soft;exposed at tube
bottom at 5.5' (possible slide
plane as in 57194 at 4') in
upper portion of tube
ASI sample# BH00243AS.

0.3' Drill
w/ 8.25" ID augers
3'-3.2' push Shelby
trash tube;no rec.
drill to 4'
(possibly smoothed out
at 4'
4'-5.9' push Shelby
smooth easy push (up
to 1000#)
bottom approx. 0.4'
slipped out of tube
cut off 5.5-5.9'
therefore: tube samp.
contain 4'-5.5' sample
top end of tube appears
to be GC FILL possibly
slough

Appendix 2

Surface Mapping and Geotechnical Laboratory Data

Appendix 3

Analysis of Laboratory Data

Department of Energy
Rocky Flats Plant
Operable Unit 5
Slope Stability Analysis
Dr. Thomas L. McGehee

Analysis of Laboratory Data

This report contains a brief examination of the data base collected by Rust Environmental and analyzed by Advanced Terra Testing to determine why these analyses were performed. The data consists of standard ASTM geotechnical analyses collected for the evaluation of USCS soil classification and slope stability analysis of soils. The following is an examination of the data base in light of the standard slope stability analysis performed by geotechnical engineers.

Atterberg Limits (Determining the consistency of the soil.) ASTM D 4318 - The moisture content, in percent, at which the soil transitions from solid, semisolid, plastic, and liquid behavior is measured in the Atterberg Limits Test. The moisture content at which the transition from solid to semisolid state takes place is defined as the shrinkage limit. The Atterberg Limits (percent moisture content) at the point of transition from semisolid to plastic state is the plastic limit, and from plastic to liquid state is the liquid limit.

Shrinkage limit - Soil shrinks as moisture is gradually lost from it. With continuing loss of moisture, a stage of equilibrium is reached at which more loss of moisture will result in no further volume change. The soil moisture percent at which the -40 sieve fraction, soil mass ceases to change is defined as the shrinkage limit.

Plastic Limit - The plastic limit is defined as the - 40 sieve fraction, soil percent moisture content at which the soil crumbles, when rolled into threads of 3.2 mm in diameter.

Liquid Limit - The moisture content of the soil, in percent, and the corresponding number of blows are plotted on semilogarithmic graph paper. The relationship between moisture content and log N is approximated as a straight line. This is referred to as the flow curve. The moisture content corresponding to $N=25$, determined from the flow curve, gives the liquid limit of the soil. For routine laboratory tests, it may be used to determine the liquid limit when only one test is run for a soil (one point method). This has been adopted by ASTM under designation D-4318. The reason that the one point method yields fairly good results is that a small range of moisture content is involved where $N=20$ to $N=30$. Casagrande (1932) concluded that each blow in a standard liquid limit device corresponds to a soil shear strength of about 1 g/cm^2 . Hence, the liquid limit of a fine-grained soil gives the moisture content at which the shear strength of the soil is approximately 25 g/cm^2 .

Clay Mineral Influence - The presence of "sensitive" clay minerals in soil mass can have significant effect on the properties of the soil. A somewhat indirect method of obtaining information on the type and effect of clay minerals in the soil is to relate plasticity to the quantity of clay sized particles. The "activity" of a soil can be derived mathematically by dividing the percent plasticity index by the percentage of clay. A graphical method using the Unified Soil Classification System (USCS) plasticity chart for the classification of fine grained soils is used in the absence of clay mineral characterization. A Plasticity Chart plot of the liquid limit value against the plasticity index value is normally included in the laboratory reports.

Atterberg Test Interpretation - The laboratory report includes the calculations of the plastic limit, the liquid limit, and the Flow Curve/Plasticity Chart at the bottom of the page. The geotechnical interpretation of the graphs produced from the ASTM D 4318 tests involves the determination of the liquid limit (at N=25), the plasticity index (PI) of the soil vrs the liquid limit (LL) point plotted. The spacial relationship to the U-line and A-line indicates the type of plasticity the silts and/or clays exhibit in the -40 fraction of the soil.

BH00229AS, 56794, 6-8' LL 58%, PI 43 (clay/high plasticity)
BH00232AS, 56794, 0-12' LL 49.9%, PI 34 (clay/mod. plasticity)
BH00218AS, 56894, 9.5-11.5' LL 63%, PI 41.8 (clay/high plast.)

BH00185AS, 56994, 2.6-3.4' nonplastic
BH00186AS, 56994, 6-6.9' LL 35.4%, PI 17.3 (clay/mod. plast.)
BH00188AS, 56994, 0-11' LL 43%, PI 25 (clay/mod. plast.)
BH00190AS, 56994, 17-19' LL 34%, PI 17.9 (clay/mod. plast.)

BH00138AS, 57094, 6-8.4' LL 41.0%, PI 26.6 (clay/mod. plast.)
BH00140AS, 57094, 10-10.5' LL 57.5%, PI 39.5 (clay/high plast.)
BH00142AS, 57094, 14.5-15.5' LL 57.5%, PI 35.1 (clay/mod. plast.)
BH00143AS, 57094, 18-19.5' LL 65.8%, PI 48.8 (clay/high plast.)
BH00144AS, 57094, 18.5-20' LL 72.9%, PI 52.1 (clay/high plast.)

BH00192AS, 57194, 7-8.9' LL 68.0%, PI 40.9 (clay/high plast.)
BH00194AS, 57194, 17-17.9' LL 53.5%, PI 31.9 (clay/mod. plast.)

BH00175AS, 57494, 8-10.5' LL 66.3%, PI 49.9 (clay/high plast.)

BH00199AS, 57694, 8-10' LL 65.6%, PI 43.8 (clay/high plast.)
BH00129AS, 57794, 4-5.8' LL 60.8%, PI 45.1 (clay/high plast.)

BH00170AS, 59294, 10-10.5' LL 45.8%, PI 31.0 (clay/mod. plast.)
BH00171AS, 59294, 12-13.2' LL 52.3%, PI 30.4 (clay/mod. plast.)
BH00172AS, 59294, 16-18' LL 70.6%, PI 51.2 (clay/high plast.)

BH00134AS, 59594, 0-22' LL 33.2%, PI 20.3 (clay/mod. plast.)
BH00135AS, 59594, 24-26.5' LL 56.2%, PI 40.4 (clay/high plast.)
BH00136AS, 59594, 8.5-8.9' LL 32.6%, PI 17.0 (clay/mod. plast.)

BH00215AS, 59694, 0-15' LL 47.1%, PI 32.0 (clay/mod. plast.)
 BH00178AS, 59794, 17-18' LL 55.7%, PI 33.0 (clay/mod. plast.)
 BH00182AS, 59794, 11.5-12.3' LL 53.4%, PI 38.7 (clay/high plast.)
 BH00183AS, 71194, 14-16' LL 66.8%, PI 44.7 (clay/high plast.)
 BH00206AS, 71294, 10-12' LL 63.4%, PI 43.0 (clay/high plast.)
 BH00208AS, 71294, 21-22' LL 62.6%, PI 40.7 (clay/high plast.)

The activity of the clay in the -40 soil fraction

BH00232AS, 56794, 0-12' BSS Normal clay, A = 1.11
 BH00188AS, 56994, 0-11' BSS Active clay, A = 3.623
 BH00138AS, 57094, 6-8.4' Active clay, A = 1.49
 BH00140AS, 57094, 10-10.5' Normal clay, A = 1.16
 BH00142AS, 57094, 14.5-15.5' Active clay, A = 5.48
 BH00175AS, 57494, 8-10.5' Active Clay, A = 1.29
 BH00170AS, 59294, 10-10.5' Normal Clay, A = 1.04
 BH00134AS, 59594, 0-22' BSS Active Clay, A = 1.85
 BH00135AS, 59594, 24-26.5' Normal clay, A = 1.13
 BH00215AS, 59694, 0-15' BSS Active clay, A = 1.93
 BH00178AS, 59794, 17-18' Normal clay, A = 0.81
 BH00183AS, 71194, 14-16' Normal clay, A = 0.87

Specific Gravity - (Determining the ratio of the unit weight of a material to the unit weight of pure water at 4 °C.) ASTM D 854 -

Specific Gravity Interpretation

BH00232AS, 56794, 0-12', 2.72
 BH00138AS, 57094, 6-8.4', 2.69
 BH00139AS, 57094, 5.0-5.5', 2.66
 BH00140AS, 57094, 10-10.5', 2.70
 BH00142AS, 57094, 14.5-15.5', 2.70
 BH00175AS, 57494, 8-10.5', 2.71
 BH00134AS, 57594, 0-22.0', 2.69
 BH00170AS, 59294, 10-10.5', 2.71
 BH00135AS, 59594, 24-26.5', 2.73

BH00215AS, 59694, 0-15',	2.72
BH00178AS, 59794, 17-18',	2.70
BH00183AS, 71194, 14-16',	2.72

Unconfined Compressive Strength (Similar to a triaxial test but with the undrained shear strength independent from the confining pressure c_u .) ASTM D 2166 - This is a special type of unconsolidated-undrained test that is commonly used for clay rich soils. This test is usually run to test the short term effects of the slope stability of clay soils. At failure the total minor principal stress is 0 and the total major principal stress is σ_1 .

Unconfined Compressive Strength Test Interpretation - This is a special type of unconsolidated-undrained test that is commonly used for clay specimens. In this test, the confining pressure σ_3 is 0. An axial load is rapidly applied to the specimen to cause failure. At failure the total minor principle stress is 0 and the total major principle stress is σ_1 . Theoretically, for similar saturated clay specimens, the unconfined compression tests and the unconsolidated-undrained triaxial tests should yield the same values of c_u . However, unconfined compression tests on saturated clays yield slightly lower values of c_u than those obtained from unconsolidated-undrained tests.

BH00138AS, 57094, 6.0-8.4'	$c = 1690$	$\phi = 0$
BH00175AS, 57594, 8-10.5'	$c = 706$	$\phi = 0$
BH00212AS, 59694, 7-9'	$c = 1182$	$\phi = 0$

Moisture Content (% Dry Weight) - ASTM D 2216

BH00228AS, 56794, 2-3.5',	14.8%
BH00230AS, 56794, 9-10',	20.0%
BH00232AS, 56794, 0-12',	17.9%
BH00188AS, 56994, 0-11',	4.2%
BH00189AS, 56994, 15-16',	13.9%
BH00140AS, 57094, 10-10.5',	8.1%
BH00193AS, 57194, 11-11.9',	21.1%
BH00195AS, 57194, 23-24',	17.3%
BH00196AS, 57194, 31-32',	14.8%
BH00128AS, 57794, 2-2.5',	9.0%

BH00170AS, 59294, 10-10.5',	14.3%
BH00211AS, 59694, 3-4',	9.8%
BH00213AS, 59694, 12-13',	13.9%
BH00215AS, 59694, 0-15',	13.8%
BH00204AS, 71294, 6-7.2',	7.5%
BH00205AS, 71294, 7.2-8',	19.4%
BH00207AS, 71294, 13.5-14.4',	18.9%
BH00209AS, 71294, 25-26',	18.5%
BH00210AS, 71294, 32.8-34.3'	18.6%

Moisture (% Dry Weight) & Dry Density ASTM D 2216 & ASTM D 2937

BH00231AS, 56794, 12-14',	31.5%	94.8
BH00187AS, 56994, 13-15',	12.4%	99.2
BH00190AS, 56994, 17-19',	16.9%	90.4
BH00191AS, 56994, 25-27',	22.0	100.6
BH00139AS, 57094, 5.0-5.5',	11.7%	not meas.
BH00141AS, 57094, 10.5-12.5',	18.8%	96.8
BH00142AS, 57094, 14.5-15.5',	10.4%	106.2
BH00176AS, 57494, 10.5-13'	18.0%	105.0
BH00177AS, 57494, 18.8-20.5',	20.8%	106.0
BH00197AS, 57694, 2-4',	15.1%	not meas.
BH00129AS, 57794, 4-5.8',	15.1%	98.6
BH00202AS, 59094, 4.0-5.2',	15.1%	not meas.
BH00214AS, 59694, 13-15',	15.7%	116.0
BH00178AS, 59794, 17-18',	19.4%	102.4
BH00182AS, 59794, 11.5-12.3',	5.3%	not meas.
BH00183AS, 71194, 14-16',	22.8%	99.9
BH00184AS, 71194, 16-17.2,	16.5%	108.0
BH00208AS, 71294, 21-22',	18.4%	not meas.

Modified Proctor Compaction ASTM D 1557 - In the proctor test, the soil is compacted in a mold. During the laboratory test, the mold is attached to a base plate at the bottom and to an extension at the top. The soil is mixed with varying amounts of water, spread into three layers, and then compacted by a hammer that delivers 25 blows to each layer. For each test the moist weight of compaction can be calculated. With known moisture content, the dry unit weight can be calculated. The values determined can be plotted against the corresponding moisture contents to obtain the maximum

dry unit weight and the optimum moisture content for the soil. For a given moisture content, the theoretical maximum dry unit weight is obtained when there is no air in the void spaces-that is, when the degree of saturation equals 100%. Thus the maximum dry unit weight at a given moisture content with zero air voids can be calculated.

Compaction values representing field conditions can be obtained from the modified proctor test. For conducting the modified Proctor Test, the same mold is used. However, the soil is compacted in five layers by a hammer that weighs 10 lbs. The number of hammer blows for each layer is kept at 25 as in the standard Proctor Test. Because it increases the compactive effort, the modified Proctor Test results in an increase of the maximum dry unit weight of the soil. The increase in the maximum dry unit weight of the soil is accompanied by a decrease of the optimum moisture content.

Values in this table include the maximum dry unit weight and the optimum moisture content.

BH00232AS, 56794, 0-12', 122.3 lbs/ft ³	12.8%
BH00188AS, 56994, 0-11', 137.3 lbs/ft ³	5.6%
BH00134AS, 59594, 0-22', 138.1 lbs/ft ³	6.9%
BH00215AS, 59694, 0-15', 130.5 lbs/ft ³	10%

Hydrometer Analysis w/ Mechanical Grain Size Analysis ASTM D 422
(see laboratory data) This information is useful in the Unified Soil Classification System (USCS) which uses soil properties (such as the Atterberg Limits test) and grain sizes to classify soil type.

USCS Soil Classification D-2487

BH00232AS, 56794, 0-12', 71%-F, 9%-G, 18%-S
CL, lean clay with sand

BH00188AS, 56994, 0-11', 17.7%-F, 43%-G, 16%-S
GC, clayey gravel with sand

BH00138AS, 57094, 6-8.4', 39.2%-F, 20%-G, 26%-S
GC, clayey gravel with sand

BH00139AS, 57094, 5-5.5', 11%-F, 55%-G, 10%-S
GP-GC, poorly graded gravel with clay

BH00140AS, 57094, 10-10.5', 63.1%-F, 9%-G, 25%-S
CH, sandy fat clay

BH00142AS, 57094, 14.5-15.5', 10.1%-F, 71%-G, 10%-S
GP-GC, poorly graded gravel with clay

BH00175AS, 57494, 8-10.5', 96%-F, 0%-G, 4%-S
CH, fat clay

BH00170AS, 59294, 10-10.5', 66.3%-F, 1%-G, 34%-S
CL, sandy lean clay

BH00134AS, 59594, 0-22', 39.2%-F, 19%-G, 33%-S
SC, clayey sand with gravel

BH00135AS, 59594, 24-26.5', 64.8%-F, 2%-G, 32%-S
CH, sandy fat clay

BH00215AS, 59694, 0-15', 48.6%-F, 12%-G, 35%-S
SC, clayey sand

BH00178AS, 59794, 17-18', 97%-F, 0%-G, 4%-S
CH, lean clay

BH00183AS, 71194, 14-16', 95.9%-F, 0%-G, 4%-S
CH, fat clay

Grain Size Analysis, -200 Sieve only (%fines/Moist.) ASTM D 1140

BH00229AS, 56794, 6-8',	58.6%	15.1%
BH00185AS, 56994, 2.6-3.4',	4.1%	0.3%
BH00186AS, 56994, 6-6.9',	16.4%	8.4%
BH00190AS, 56994, 17-19',	28.2%	16.5%
BH00143AS, 57094, 18-19.5',	60.1%	14.1%
BH00144AS, 57094, 18.5-20',	62.1%	20.5%
BH00192AS, 57194, 7-8.9',	97.9%	21.1%
BH00194AS, 57194, 17-17.9,	97.7%	15.4%
BH00199AS, 57694, 8-10',	99.9%	23.6%
BH00171AS, 59294, 12-13.2',	97.1%	17.5%
BH00172AS, 59294, 16-18',	97.6%	19.7%
BH00132AS, 59594, 8.5-8.9',	31.2%	4.7%
BH00133AS, 59594, 11-22.0',	19.9%	1.9%
BH00136AS, 59594, 35-35.8',	57.8%	17.6%

Triaxial Shear - TX/CUpp (A consolidated-undrained test with pore

pressure monitored) ASTM D 4767 (failure envelope)

BH00229AS, 56794, 6-8',	c= 0	ϕ = 45.5
	c= 1120	ϕ = 0
BH00218AS, 56894, 9.5-11.5',	c= 0	ϕ = 40.5
	c= 1268	ϕ = 0
BH00145AS"A", 57094, 28.5-30',	c= 0	ϕ = 31.5
BH00145AS"B", 57094, 28.5-30',	c= 0	ϕ = 29
	c= 1150	ϕ = 15
BH00198AS, 57694, 6-8',	c= 0	ϕ = 40.5
	c= 609	ϕ = 0
BH00199AS, 57694, 8-10',	c= 0	ϕ = 32
	c= 904	ϕ = 0
BH00200AS, 57694, 12-14',	c= 0	ϕ = 27.5
	c= 1030	ϕ = 0
BH00171AS, 59294, 12-13.2',	c= 0	ϕ = 34.5
	c= 1369	ϕ = 0
BH00172AS, 59294, 16-18',	c= 0	ϕ = 28.5
	c= 1541	ϕ = 0
BH00173AS, 59294, 23-24.7',	c= 0	ϕ = 30.5
	c= 2139	ϕ = 0
BH00135AS"A", 59594, 24-26.5',	c= 0	ϕ = 33
BH00135AS"B", 59594, 24-26.5',	c= 0	ϕ = 45.7
BH00135AS"C", 59594, 24-26.5',	c= 0	ϕ = 33
	c= 2000	ϕ = 17.5
BH00206AS, 71294, 10-12',	c= 0	ϕ = 55.5
	c= 1463	ϕ = 0
BH00243AS, 71494, 4-5.5',	c= 0	ϕ = 26.5
	c= 730	ϕ = 0

Consolidation Test ASTM D 2435 - The soil samples run in the consolidation test method (ASTM D 2435) were subjected to an increasing load test and to four independent separate confining pressure tests. After the time-deformation plots for various loadings are obtained in the laboratory, it is necessary to study the change in the void ratio of the specimen with pressure. The total pressures p and the corresponding void ratios at the end of the consolidation are plotted on semilogarithmic graph paper. This curve is referred as the e -log p curve.

A soil in the field at some depth has been subjected to a certain maximum effective past pressure in its geologic history. This maximum effective past pressure may be equal to or less than the existing overburden pressure at the time of sampling. The reduction of pressure in the field may be caused by natural geologic processes or human processes. During the soil sampling, the existing overburden pressure on the soil below is also released, resulting in some expansion. When this specimen is subjected to a consolidation test, a small amount of compression (a small change in void ratio) will occur when the total pressure applied is less than the maximum effective overburden pressure in the field to which the soil has been subjected in the past. When the total applied pressure on the specimen is greater than the

maximum effective past pressure, the change in the void ratio is much larger, and the e -log p relationship is practically linear with a steeper slope.

There are two definitions of clay soils based on stress history:

1. Normally consolidated, whose present effective overburden pressure is the maximum pressure that the soil has been subjected to in the past
2. Overconsolidated, whose present effective overburden pressure is less than that which the soil has experienced in the past. The maximum effective past pressure is called the preconsolidation pressure.

A soil specimen will be remolded when it is subjected to some degree of disturbance. This will effect the void ratio-pressure relationship for the soil. For a normally consolidated clayey soil of low to medium sensitivity under an effective overburden pressure and void ratio, the change in the void ratio with an increase in pressure in the field will be a steeply-sloping straight line (virgin consolidation) curve located to the right of the laboratory consolidation curve. If the soil is completely remolded in a laboratory test, the curve will plot to the left of the laboratory consolidation curve of an unmolded sample.

For an overconsolidated clayey soil of low to medium sensitivity that has been subjected to a preconsolidation pressure for which the present in situ effective overburden pressure and the void ratio are p_0 and e_0 , respectively, the field consolidation curve will take the shape of a pronounced "knee". The lower part of the curve is a part of the virgin compression curve. The "knee" slope is the field recompression path. The upper part of the curve is reconsolidation curve. An empiricle procedure to estimate void ratio-pressure relationships overconsolidated clayey soil is demonstrated in Das, 1994. For a given overburden pressure, p , the void ratio in the field can be estimated if the liquid limit and the specific gravity of the soil solid are known.

BH00138AS, 57094, 6-8.4', LL-41.0, SG (g/cm^3)-2.690
1600 psf
3200 psf
6400 psf
12800 psf

BH00144AS, 57094, 18.5-20', LL-72.0, SG (g/cm^3)-2.700
1600 psf
3200 psf
6400 psf
12800 psf

BH00172AS, 59294, 16-18', LL-70.6, SG (g/cm^3)-2.700
1600 psf
3200 psf
6400 psf

12800 psf

BH00135AS, 59594, 24-26.5', LL-56.2, SG (g/cm³)-2.730

1600 psf

3200 psf

6400 psf

12800 psf

BH00178AS, 59794, 17-18', LL-55.7, SG (g/cm³)-2.700

1600 psf

3200 psf

6400 psf

12800 psf

Direct Shear ASTM D 3080 - The coefficient of permeability of clay is very small compared with that of sand. When a normal load is applied to a clay soil specimen, a sufficient length of time must elapse for full consolidation (dissipation of excess pore water pressure). The shearing load has to be applied at a very slow rate. The test may last up to 2-5 days. The direct shear test is simple to perform, but it can be criticized for its reliability. This is because in this test the soil is not allowed to fail along the weakest plane but of split of the shear box. Also, the shear stress distribution over the shear stress of the specimen is not uniform. In spite of these shortcomings, the direct shear test is the simplest and most economical for a dry or saturated sandy soil.

In many foundation design problems, it will be necessary to determine the angle of friction between the soil and the material in which the foundation is constructed. The shear strength along the surface of contact of the soil and the foundation can be measured.

The direct shear test can be used to determine long term loading on slope stability. This is particularly important if steady seepage occurs in the landfill. This test generally is drawn through the origin (no cohesion intercept) with a high internal friction angle (ϕ).

BH00231AS, 56794, 12-14'

shear def. - .070 shear stress - 1752 (fail.) axial def. .0050

BH00172AS, 59294, 16-18'

shear def. - .060 shear stress - 2148 (fail.) axial def. .0054

BH00183AS, 71194, 14-16'

shear def. - .045 shear stress - 1356 (fail.) axial def. .0015

BH00243AS"A", 71494, 4-5.5'

shear def. - .011 shear stress - 4164 (fail.) axial def. .0427

BH00243AS"B", 71494, 4-5.5'

shear def. - .130 shear stress - 3624 (fail.) axial def. .0691

Log of *Shelby Tube, **Bulk or Bucket, and 1 gal Bag Samples
(Shelby Tube interval described from bottom to top of tube as received from the field)

BH00228AS, 56794, Colluvium 2-3.5'
Moisture Content

*BH00229AS, 56794 (page 317), Colluvium 6-8'
0-6" CL
Triaxial Compression Test (pore pressure)
6-12" CL
Atterberg Limits Test
-200 sieve analysis
12-17" CL, no tests

BH00230AS, 56794, Colluvium 9-10'
Moisture Content

*BH00231AS, 56794 (page 318), Colluvium/Claystone 12-14"
0-6" CL
Moisture and Density
6-9" CL
Direct Shear Test
Slickensides @ 8" *
9-14" CL, no tests
14-23" SW, no tests

**BH00232AS, 56794, Claystone 9-10'
Moisture Content
Atterberg Limits
Sieve Analysis
Compaction Test

*BH00218AS, 56894 (page 316), 9.5-11.5'
0-7" ML, no tests
7-14" ML
Atterberg Limits test
14-21" ML
Triaxial Compression Test (pore pressure)

BH00185AS, 56994, Waste Fill 2.6-3.4'
Moisture Content
Atterberg Limits
-200 Sieve Fraction

BH00186AS, 56994, Waste Fill 6-6.7'
Moisture Content
Atterberg Limits
-200 Sieve Fraction

*BH00187AS, 56994 (page 287), Waste Fill 13-15'
0-6" CL, no test
6-12" SP
Moisture & Density

12-19" SP, no test
19-26" CL, no test
26-28" CL, no test

**BH00188AS, 56994, Waste Fill 0-11'

Moisture Content
Atterberg Limits
Sieve Analysis
Compaction Test

BH00189AS, 56994, Rocky Flats Alluvium 15-16'

Moisture Content

*BH00190AS, 56994 (page 288), Rocky Flats Alluvium 17-19'

0-6" SP/CL
Moisture and Density
6-12" SP/CL
Atterberg Limits Test
-200 sieve analysis

12-21" SP/CL, no tests

*BH00191AS, 56994 (page 289), Claystone 25-27'

1-6" CL
Moisture and Density
Numerous Slickensided areas *
6-13" CL, no tests
Slickensided at bottom
13-20" CL, no tests
20-24" CL (grey clay) and SP (fingers of orange-brown sand)
no tests

*BH00138AS, 57094 (page 297), 6.0-8.4'

0-3" CL
Consolidation Test
3-9" CL
Unconfined Compressive Strength Test
9-19" CL
Atterberg Limits Test
Grain Size Analysis Test
Hydrometer Test
19-21" CL, no test

BH00140AS, 57094, Colluvium 10-10.5'

Moisture Content
Visual Classification

*BH00141AS, 57094 (page 286), Colluvium 10.5-12.5'

3-6" Moisture & Density
6-8" no test
8-12" no sample (wax and voids)

*BH00142AS, 57094 (page 298), Colluvium 14.5-15.5'

0-6" GP, no tests

*****Page 364 ???

Moisture Content
Unit Weight
Atterberg Limits
Sieve Analysis
Visual Classification
Log of Tube Sample

BH00143AS, 57094, Colluvium 18-18.5'

Moisture Content
Atterberg Limits
-200 Sieve Fraction

*BH00144AS, 57094 (page 299), 18.5-20'

0-5" no sample
5-6" CL
Consolidation Test
6-13" CL
Atterberg Limit Test

*BH00145AS, 57094 (page 300), 28.5-30'

0-6" CL
Triaxial Compression Test (pore pressure)
6-11" CL
Triaxial Compression Test (pore pressure)
11-25" CL, no test

*BH00192AS, 57194 (page 310), 7-8.9'

1-8"
Atterberg Limits Tests
-200 sieve analysis
8-13"
Atterberg Limits Tests
-200 sieve analysis
13-15" , no tests
15-21" , no tests

BH00193AS, 57194, Claystone 11-11.9'

Moisture Content

BH00194AS, 57194, Claystone 17-17.9'

Moisture Content
Atterberg Limits
-200 sieve Analysis

BH00195AS, 57194, Claystone 23-24'

Moisture Content

BH00196AS, 57194, Claystone 31-32'

Moisture Content

*BH00175AS, 57494 (page 304), Colluvium 8-10.5'

0-6" CL

Unconfined Compressive Strength Test
6-12" CL
Atterberg Limits Test
Grain Size Analysis
Hydrometer Analysis
12-18" CL, no tests
18-24" CL, no tests

*BH00176AS, 57494 (page 305), Claystone 10.5-13'

0-6" CL
Moisture and Density
6-13" CL, no tests
13-20" CL, no tests
20-29" CL, no tests

*BH00177AS, 57494 (page 306), Claystone 18.5-20.5'

0-6" CL
Moisture and Density
6-13" CL, no tests
13-20" CL, no tests
fracture at 14.8' *

*BH00197AS, 57694 (page 290), Colluvium/Claystone 2-4'

0-7" SM/ML
Moisture Content
7-14" SM/ML, no tests
vertical crack down center *
14-22" SM
no tests

*BH00198AS, 57694 (page 311), 6-8'

0-6" CL
Triaxial Compression Test (pore pressure)
6-12" CL, no tests
12-24" CL, no tests

*BH00199AS, 57694 (page 312), 8-10'

0-6" CL
Triaxial Compression Test (pore pressure)
6-12" CL
Atterberg Limits Test
-200 sieve fraction

*BH00200AS, 57694 (page 313), 12-14'

0-6" CL
Triaxial Compression Test (pore pressure)
6-12" CL, no tests
12-25" CL, no tests

BH00128AS, 57794, Colluvium 2-2.5'

Moisture Content
Visual Classification

*BH00129AS, 57794, (page 285), Colluvium 4-5.8'

0-6" Damaged, no test
6-12" CL/ML
Atterberg limits Test
Grain Size Analysis
Hydrometer Test
Specific Gravity
12-17" CL/ML
Moisture and Density

*BH00202AS, 59094 (page 291), Colluvium/Claystone 4-5.2'

2-8" ML
Moisture Content
8-14" ML, no test

BH00170AS, 59294, Colluvium 10-10.5'

Moisture Content
Atterberg Limits
Sieve Analysis

*BH00171AS, 59294 (page 301), 12-13.2'

4-10" CL
Atterberg Limit Test
-200 sieve fraction
10-17" CL
Triaxial Compression Test (pore pressure)

*BH00172AS, 59294 (page 302), 16-18'

0-6" CL
Triaxial Compression Test (pore pressure)
6-7" CL
Consolidation Test
7-9" CL
Direct Shear Test
9-13" CL
Atterberg Limits Test
-200 sieve fraction

*BH00173AS, 59294 (page 303), 23.0-24.7'

0-7" CL
Triaxial Compression Test (pore pressure)
7-12" CL, no tests
12-19" CL, no tests

*BH00135AS, 59594 (page 296), 24-26.5'

1-3" CL
Consolidation Test
3-9" CL
Triaxial Compression Test (pore pressure) A
9-15" CL
Triaxial Compression Test (pore pressure) B
15-21" CL
Triaxial Compression Test (pore pressure) C
21-25" CL

Atterberg Limits Test
Grain Size Analysis
Hydrometer Test
25-29" CL, no test

BH00211AS, 59694, FA 3-4'
Moisture Content

*BH00212AS, 59694 (page 315), FA 7-9'

0-3" GP
3-10" GP, no tests
10-16" GP
Unconfined Compressive Strength Test
16-23" GP, no tests

BH00213AS, 59694, FA 12-13'
Moisture Content

*BH00214AS, 59694 (page 292), Colluvium 13-15'

0-7" SP/CL
Moisture and Density
7-12" CL, no test

**BH00215AS, 59694, Fill 0-15'

Moisture Content
Atterberg Limits
Sieve Analysis
Compaction Test

*BH00178AS, 59794 (page 307), Claystone 17-18'

0-6" CL
Moisture and Density
6-8" CL
Consolidation Tests
8-15" CL
Atterberg Limits Test
Grain Size Analysis
Hydrometer Test

*BH00183AS, 71194 (page 308), Claystone 14-16'

0-6" CL
Moisture and Density
6-9" CL
Direct Shear Test
9-13" CL
Atterberg Limits Test
13-15" CL
Grain Size Analysis
Hydrometer Tests
15-24" CL, no tests

*BH00184AS, 71194 (page -309), Claystone 16-17.5'

0-6" CL

Moisture and Density
6-12" CL, no tests
12-17" CL, no tests

BH00204AS, 71294, Colluvium 6-7.2'
Moisture Content

BH00205AS, 71294, Claystone 7.2-8'
Moisture Content

*BH00206AS, 71294 (page 314), Claystone 10-12'
0-6" ML
Triaxial Compression Test (pore pressure)
6-12" ML, no tests
12-21" ML
Atterberg Limits Test

BH00207AS, 71294, Claystone 13.5-14.4'
Moisture Content

BH00208AS, 71294, Claystone 21-22'
Moisture Content
Atterberg Limits

BH00209AS, 71294, Claystone 25-28'
Moisture Content

BH00210AS, 71294, Claystone 32.8-34.3'
Moisture Content

*BH00243AS, 71494 (page 319), Fill/Claystone 4-5.5'
0-6" ML
Triaxial Compression Test (pore pressure)
6-9" ML
Direct Shear Test (replaces BH00192AS ***)
9-12" ML
Direct Shear Test
12-16" ML, no tests
16-20" SM, no tests

Log of *Shelby Tube, **Bulk or Bucket, and 1 gal Bag Samples
by BOREHOLE (Shelby Tube interval described from top to bottom of
tube as received from the field)

BOREHOLE 56794 LABORATORY SAMPLES

BH00228AS, 56794, Colluvium 2-3.5'

✓ Moisture Content 14.8%

*BH00229AS, 56794 (page 317), Colluvium 6-8'

12-17" CL, no tests

6-12" CL

✓ Atterberg Limits Test LL 58% P₁ 43

✓ -200 sieve analysis 58.6%, 15.1%

0-6" CL

✓ Triaxial Compression Test (pore pressure) C₂₀ 45.5

BH00230AS, 56794, Colluvium 9-10'

✓ Moisture Content 20%

*BH00231AS, 56794 (page 318), Colluvium/Claystone 12-14"

14-23" SW, no tests

9-14" CL, no tests

6-9" CL

Direct Shear Test

Slickensides @ 8" *

0-6" CL

✓ Moisture and Density 31.5%, 77.8

**BH00232AS, 56794, Claystone 9-10'

Moisture Content

Atterberg Limits

Sieve Analysis

Compaction Test

BOREHOLE 56894 LABORATORY SAMPLES

*BH00218AS, 56894 (page 316), 9.5-11.5'

14-21" ML

Triaxial Compression Test (pore pressure) $C=0$ $\phi=40.5^\circ$

7-14" ML

Atterberg Limits test $U=63\%$, $P=41.8$

0-7" ML, no tests

BOREHOLE 56994 LABORATORY SAMPLES

BH00185AS, 56994, Waste Fill 2.6-3.4'

Moisture Content

Atterberg Limits *non plastic*

-200 Sieve Fraction 4.1%, 0.3%

BH00186AS, 56994, Waste Fill 6-6.7'

Moisture Content

Atterberg Limits LL 35.4, PI 17.3

-200 Sieve Fraction 16.4%, 0.4%

*BH00187AS, 56994 (page 287), Waste Fill 13-15'

26-28" CL, no test

19-26" CL, no test

12-19" SP, no test

6-12" SP

Moisture & Density 12.4%, 99.2

0-6" CL, no test

**BH00188AS, 56994, Waste Fill 0-11'

Moisture Content 4.2%

Atterberg Limits LL 43 PI 25

Sieve Analysis

Compaction Test

BH00189AS, 56994, Rocky Flats Alluvium 15-16'

Moisture Content 13.9%

*BH00190AS, 56994, (page 288), Rocky Flats Alluvium 17-19'

12-21" SP/CL, no tests

6-12" SP/CL

Atterberg Limits Test LL 34, PI 17.9

-200 sieve analysis 28.2%, 16.5%

0-6" SP/CL

Moisture and Density 16.9%, 90.4

*BH00191AS, 56994 (page 289), Claystone 25-27'

20-24" CL (grey clay) and SP (fingers of orange-brown sand)
no tests

13-20" CL, no tests

6-13" CL, no tests

Slickensided at bottom

1-6" CL

Moisture and Density 22%, 100.6

Numerous Slickensided areas *

BOREHOLE 57094 LABORATORY SAMPLES

*BH00138AS, 57094 (page 297), 6-8.4'

19-21" CL, no test

9-19" ~~CL~~ GC

Atterberg Limits Test LL-41% PI-26.6

Grain Size Analysis Test

Hydrometer Test

3-9" CL

Unconfined Compressive Strength Test $C=1690$ $\phi=0$

0-3" CL

Consolidation Test

BH00140AS, 57094, Colluvium 10-10.5'

Moisture Content 8.1%

Visual Classification

*BH00141AS, 57094 (page 286), Colluvium 10.5-12.5'

8-12" no sample (wax and voids)

6-8" no test

3-6" Moisture & Density 18.8% , 96.8

*BH00142AS, 57094 (page 298), Colluvium 14.5-15.5'

0-6" GP, no tests

*****Page 364 ???

Moisture Content

Unit Weight

Atterberg Limits LL 57.5% PI 35.1

Sieve Analysis

Visual Classification

Log of Tube Sample

BH00143AS, 57094, Colluvium 18-18.5'

Moisture Content

Atterberg Limits LL 65.8% PI 48.8

-200 Sieve Fraction 60.1% , 14.1%

*BH00144AS, 57094 (page 299), 18.5-20'

6-13" CL

Atterberg Limit Test 72.9

5-6" CL

Consolidation Test

0-5" no sample

*BH00145AS, 57094 (page 300), 28.5-30'

11-25" CL, no test

6-11" CL

Triaxial Compression Test (pore pressure) $C=0$ $\phi=29.0$

0-6" CL

Triaxial Compression Test (pore pressure) $C=0$ $\phi=31.5$

$C=1150 - \phi=15$

BOREHOLE 57194 LABORATORY SAMPLES

*BH00192AS, 57194 (page 310), 7-8.9'

15-21" , no tests

13-15" , no tests

8-13"

Atterberg Limits Tests LL 68% , PI 40.9
-200 sieve analysis 97.9% 21.1

1-8"

Atterberg Limits Tests S A A
-200 sieve analysis

BH00193AS, 57194, Claystone 11-11.9'

Moisture Content 21.1%

BH00194AS, 57194, Claystone 17-17.9'

Moisture Content

Atterberg Limits LL 53.5, PI 31.9

-200 sieve Analysis 97.7%, 15.4%

BH00195AS, 57194, Claystone 23-24'

Moisture Content 17.3%

BH00196AS, 57194, Claystone 31-32'

Moisture Content 14.8%

BOREHOLE. 57494 LABORATORY SAMPLES

*BH00175AS, 57494 (page 304), Colluvium 8-10.5'

18-24" CL, no tests

12-18" CL, no tests

6-12" CL CH

Atterberg Limits Test LL 66.3%, PI 49.9

Grain Size Analysis

Hydrometer Analysis

0-6" CL

Unconfined Compressive Strength Test C=706, $\phi=0$

*BH00176AS, 57494 (page 305), Claystone 10.5-13'1

20-29" CL, no tests

13-20" CL, no tests

6-13" CL, no tests

0-6" CL

Moisture and Density 18%, 105

*BH00177AS, 57494 (page 306), Claystone 18.5-20.5'

13-20" CL, no tests

fracture at 14.8' *

6-13" CL, no tests

0-6" CL

Moisture and Density 20.8%, 106

BOREHOLE 57694 LABORATORY SAMPLES

*BH00197AS, 57694 (page 290), Colluvium/Claystone 2-4'

14-22" SM
no tests
7-14" SM/ML, no tests
vertical crack down center *
0-7" SM/ML
Moisture Content 15.1%

*BH00198AS, 57694 (page 311), 6-8'

12-24" CL, no tests
6-12" CL, no tests
0-6" CL
Triaxial Compression Test (pore pressure) $C=0$ ϕ 40.5

*BH00199AS, 57694 (page 312), 8-10'

6-12" CL
Atterberg Limits Test LL 43.8
-200 sieve fraction 99.9%, 23.6%
0-6" CL
Triaxial Compression Test (pore pressure) $C=0$ ϕ 32

*BH00200AS, 57694 (page 313), 12-14'

12-25" CL, no tests
6-12" CL, no tests
0-6" CL
Triaxial Compression Test (pore pressure) $C=0$ ϕ 27.5

BOREHOLE 57794 LABORATORY SAMPLES

BH00128AS, 57794, Colluvium 2-2.5'

Moisture Content 9.0%

Visual Classification

*BH00129AS, 57794, (page 285), Colluvium 4-5.8'

12-17" CL/ML

Moisture and Density 15.1% , 98.6

6-12" CL/ML

Atterberg limits Test 60.8% , PI 45.1

Grain Size Analysis

Hydrometer Test

Specific Gravity

0-6" Damaged, no test

BOREHOLE. 59094 LABORATORY SAMPLES

*BH00202AS, 59094 (page 291), Colluvium/Claystone 4-5.2'

8-14" ML, no test

2-8" ML

Moisture Content 13.1%

BOREHOLE 59294 LABORATORY SAMPLES

BH00170AS, 59294, Colluvium 10-10.5'

Moisture Content 14.3%
Atterberg Limits 45.8% , $PI\ 31.0$
Sieve Analysis

*BH00171AS, 59294 (page 301), 12-13.2'

10-17" CL
Triaxial Compression Test (pore pressure) $C=0$ $\phi=34.5$
4-10" CL
Atterberg Limit Test 45.3% $PI\ 30.4$
-200 sieve fraction 97.1% , 17.5%

*BH00172AS, 59294 (page 302), 16-18'

9-13" CL
Atterberg Limits Test 47.6% , $PI\ 51.2$
-200 sieve fraction 97.6% , 19.7%
7-9" CL
Direct Shear Test
6-7" CL
Consolidation Test
0-6" CL
Triaxial Compression Test (pore pressure) 0 , 23.5

*BH00173AS, 59294 (page 303), 23-24.7'

12-19" CL, no tests
7-12" CL, no tests
0-7" CL
Triaxial Compression Test (pore pressure) 0 , 23.5

BOREHOLE 59594 LABORATORY SAMPLES

*BH00135AS, 59594 (page 296), 24-26.5'

25-29" CL, no test

21-25" CL

Atterberg Limits Test $LL\ 56.2\%$, $PI\ 40.4$

Grain Size Analysis

Hydrometer Test CH

15-21" CL

Triaxial Compression Test (pore pressure) C $0, 33^\circ$

9-15" CL

Triaxial Compression Test (pore pressure) B $0, 45.7^\circ$

3-9" CL

Triaxial Compression Test (pore pressure) A $0, 33^\circ$

1-3" CL

Consolidation Test

2000

17.5

BOREHOLE 59694 LABORATORY SAMPLES

BH00211AS, 59694, FA 3-4'

Moisture Content 9.8%

*BH00212AS, 59694 (page 315), FA 7-9'

16-23" GP, no tests

10-16" GP

Unconfined Compressive Strength Test C=1182, #0

3-10" GP, no tests

0-3" GP

BH00213AS, 59694, FA 12-13'

Moisture Content 13.9%

*BH00214AS, 59694 (page 292), Colluvium 13-15'

7-12" CL, no test

0-7" SP/CL

Moisture and Density 15.7% 116.0

**BH00215AS, 59694, Fill 0-15'

Moisture Content 15.3%

Atterberg Limits 47.1%, PI-32

Sieve Analysis

Compaction Test

BOREHOLE 59794 LABORATORY SAMPLES

*BH00178AS, 59794 (page 307), Claystone 17-18'

8-15" CL
Atterberg Limits Test ^{LL} 55.7% , PI 33.0
Grain Size Analysis
Hydrometer Test
6-8" CL
Consolidation Tests
0-6" CL
Moisture and Density 19.4% , 102.4

BOREHOLE, 71194 LABORATORY SAMPLES

*BH00183AS, 71194 (page 308), Claystone 14-16'

15-24" CL, no tests

13-15" CL

Grain Size Analysis

Hydrometer Tests - CH

9-13" CL

Atterberg Limits Test LL 66.8%, PI 44.7

6-9" CL

Direct Shear Test

0-6" CL

Moisture and Density 22.8% 99.7

*BH00184AS, 71194 (page 309), Claystone 16-17.5'

12-17" CL, no tests

6-12" CL, no tests

0-6" CL

Moisture and Density 16.5% , 108.0

BOREHOLE. 71294. LABORATORY SAMPLES

BH00204AS, 71294, Colluvium 6-7.2'

Moisture Content 7.5%

BH00205AS, 71294, Claystone 7.2-8'

Moisture Content 19.4%

*BH00206AS, 71294 (page 314), Claystone 10-12'

12-21" ML

Atterberg Limits Test LL 63.4%, PI 43.0

6-12" ML, no tests

0-6" ML

Triaxial Compression Test (pore pressure) 0, 55.5

BH00207AS, 71294, Claystone 13.5-14.4'

Moisture Content 18.9%

BH00208AS, 71294, Claystone 21-22'

Moisture Content 18.4%

Atterberg Limits LL 62.6%, PI 40.7

BH00209AS, 71294, Claystone 25-28'

Moisture Content 18.5%

BH00210AS, 71294, Claystone 32.8-34.3'

Moisture Content 18.6%

BOREHOLE 71494 LABORATORY SAMPLES

*BH00243AS, 71494 (page 319), Fill/Claystone 4-5.5'

16-20" SM, no tests

12-16" ML, no tests

9-12" ML

Direct Shear Test

6-9" ML

Direct Shear Test (replaces BH00192AS ***)

0-6" ML

Triaxial Compression Test (pore pressure) 0, 26.5°

TRIAXIAL COMPRESSION DATA P 179

ASTM D4767

Boring No. 59294

Depth 25.0 - 24.7'

Sample No. BH0019315

Confining Pressure (cell material overburden pressure) = 3600 PSF

Final stress ratio Max. 3.03, (2) 0.5789, 0.31512

C = 21385 PSF

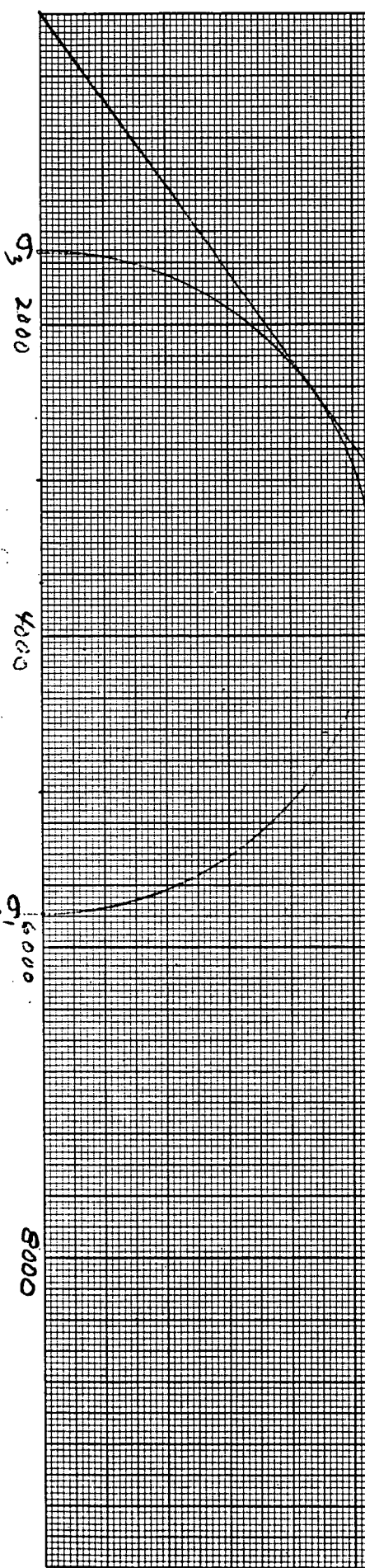
$\phi = 0^\circ$ $\rho = 30.5^\circ$

dry density
wet density

SKEMPTON'S TEST $\bar{\sigma}_1 = (2080 \text{ PSF}) \times 0.48$
 $(2080 \text{ PSF}) = 4272 \text{ PSF}$

τ PSF

Failure - 21385 PSF



TRIAxIAL COMPRESSION DATA P 173

ASTM 4467

Baring No 59294

Sample No BH00172AS

Confining Pressure (estimated overburden/pressure)

Princ. Stress Ratio Max 2.89, (a) 5, 4708, 5, 1627

C = 1540.5 psf

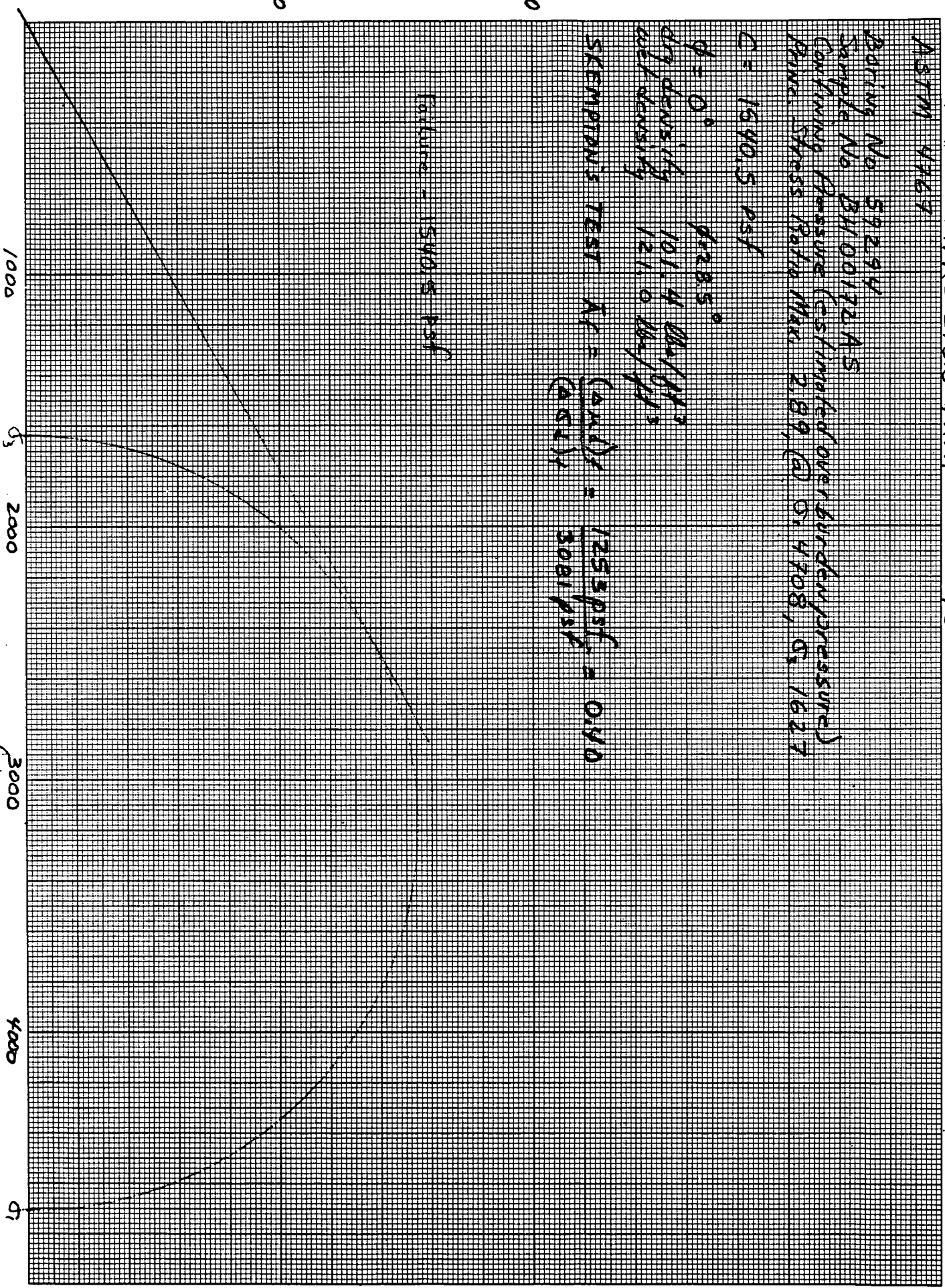
$\phi = 0^\circ$ $\phi_{28.5}^\circ$

dry density 101.4 lbm/ft³

air density 121.0 lbm/ft³

SKEMPON'S TEST $A_f = \frac{(A_{d1})}{(A_{d2})} = \frac{1253 \text{ psf}}{3081 \text{ psf}} = 0.40$

failure - 1540.5 psf



1000

2000

T psf

sigma psf

1000

5

2000

4000

5

TRIAXIAL COMPRESSION DATA

P139

ASTM D 4767

Depth 9.5-11.5'

Boring No. 56894

Sample No. BH00218A5

Sample No. BH00218A5

Estimated Overburden Pressure 1440 psf

Confining Pressure (estimated)

Principle Stress Ratio Max. = 4.83, (2) 0.3198, 0.362

Principle Stress Ratio

C = 1268 psf

$\phi = 0^\circ$

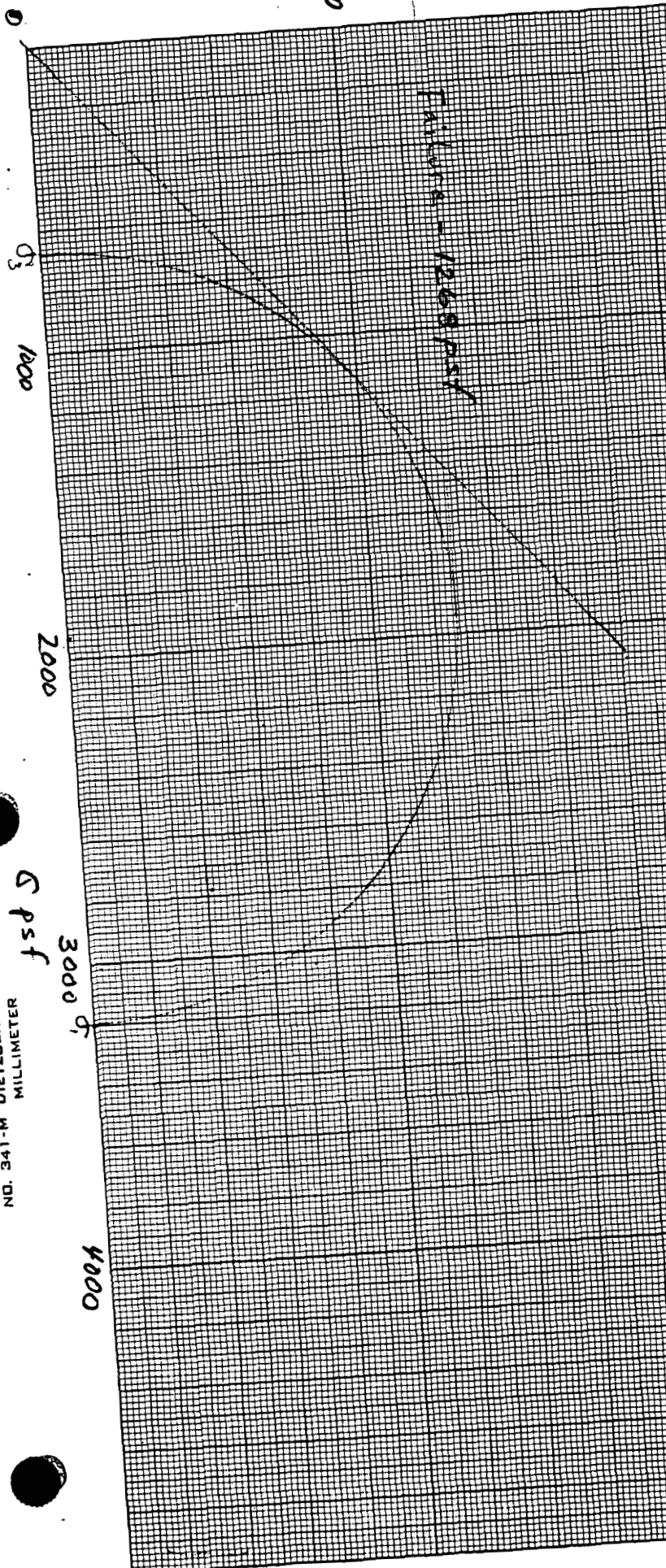
dry density 103.5 lb/ft³

wet density 134.8 lb/ft³

Skenpion's TEST $\bar{\sigma}_1 = \frac{(\sigma_1 + \sigma_2)}{2} = \frac{778 \text{ psf} + 2536 \text{ psf}}{2} = 0.30$

Failure = 1268 psf

Failure = 1268 psf



TRIAXIAL COMPRESSION DATA P 169

ASTM 4767

Boiling No. 59294

Sample No. BH00171A5

Depth 12.0-13.2'

Confining Pressure (Estimated Overburden Pressure) 2160 psf

Fluid Stress Ratio Max, 3.64, @ σ_1 3775, σ_3 1037

$C = 1369$ psf

$\phi = 0^\circ$

dry density 103.8 lb/ft³

wet density 120.7 lb/ft³

Skempton's Test

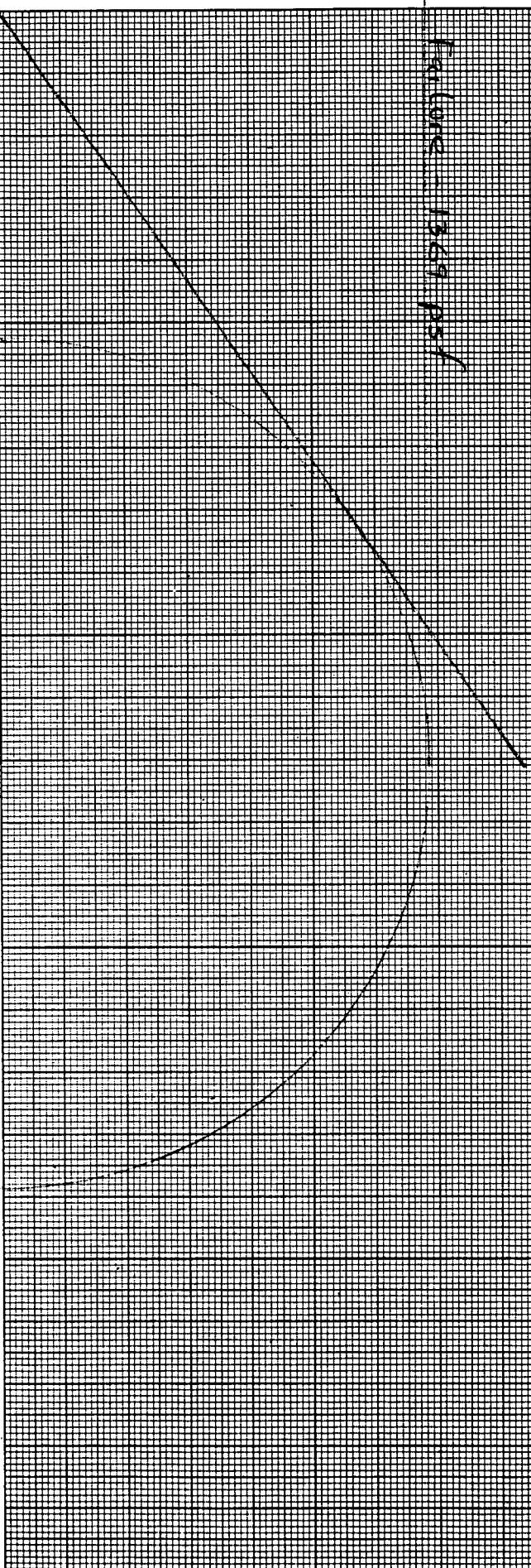
$$A_1 = \frac{(q_{ult})_c}{(c_{sc})_c} = \frac{1123 \text{ psf}}{2238 \text{ psf}} = 0.41$$

τ psf

2000

1000

Failure 1369 psf



1000

63

2000

3000

σ 4000

σ psf

TRIAXIAL COMPRESSION DATA P 204

ASTM D 4967

Boring No. 71494

Depth 4.0 - 5.5'

Sample No. BH 0024345

Confining Pressure (estimated overburden pressure) 1152 psf

Princ. Stress Ratio Max. 2164, @ 0.2353, @ 893

$C = 730 \text{ psf}$

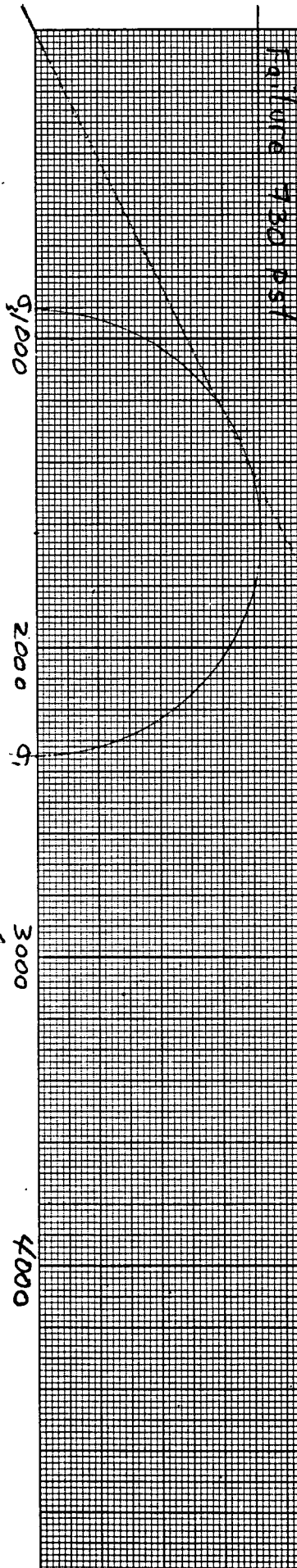
$\phi = 0^\circ$ $\phi = 20.5^\circ$

dry density 99.2 lb./cu. ft.

wet density 119.6 lb./cu. ft.

SKEMPION'S TEST $A_1 = (644) = 239 \text{ psf}$
 $(\sigma_3) = 1460 \text{ psf} = 0.17$

Failure 730 psf



1000

T psf

2000

TRIAXIAL COMPRESSION DATA P 199

ASIM 4403

Barrel No. 71299

Depth 10.0 - 12.0'

Sample No. 0400206 AS

Confining Pressure (estimated overburden pressure) 1440 psf

Principal Stress Ratio Max. 10.67, (a) 5.328, (b) 5.02

$c = 1463$ psf

$\phi = 0$

dry density 98.0 lb./ft.³

wet density 116.0 lb./ft.³

SKEMPTON'S TEST $T_1 = (4403) \times \frac{1138 \text{ psf}}{2926 \text{ psf}} = 0.38$

Failure 1463 psf

1000

2000

T psf

0

1000

2000

3000

4000

σ_3

σ psf

ASPM D 4944

Boring No. 56294 Depth 6-8'

Sample No. BH 00329 AS

Confining Pressure = Overburden Pressure estimated 1008 psf
Principal Stress Ratio Max. = 6.05, @ 5, 2874, 0, 476

C = 1199.5 psf

$\phi = 0^\circ$ $\phi_{45.5^\circ}$

dry density 116.3 lb./ft.³
wet density 133.1 lb./ft.³

Shrinkage test $\bar{R}_f = \frac{(2040) - 2359}{(2040)} = .22$

Failure - 1199.5 psf

1000

2000

0

1000

2000

3000

4000

σ - psf

τ - psf

TRIAXIAL COMPRESSION DATA P 144

ASTM D 4946

Boring No. 59094

Depth 28.5 - 30.0'

Sample No. BH100/45 AS "A"

Confining Pressure (Estimated overburden pressure) 2800 psf

Principal Stress Ratio Max. 3.20, 605, 6081, 5, 1901

$c = 2090 \text{ psf}$ $\phi = 0$

$\text{moist} = 0\%$

$\text{Max } P = 31.5\%$

dry density

105.4 psf

wet density

126.6 psf

SKEMPTON'S TEST $\bar{\sigma}_1 =$

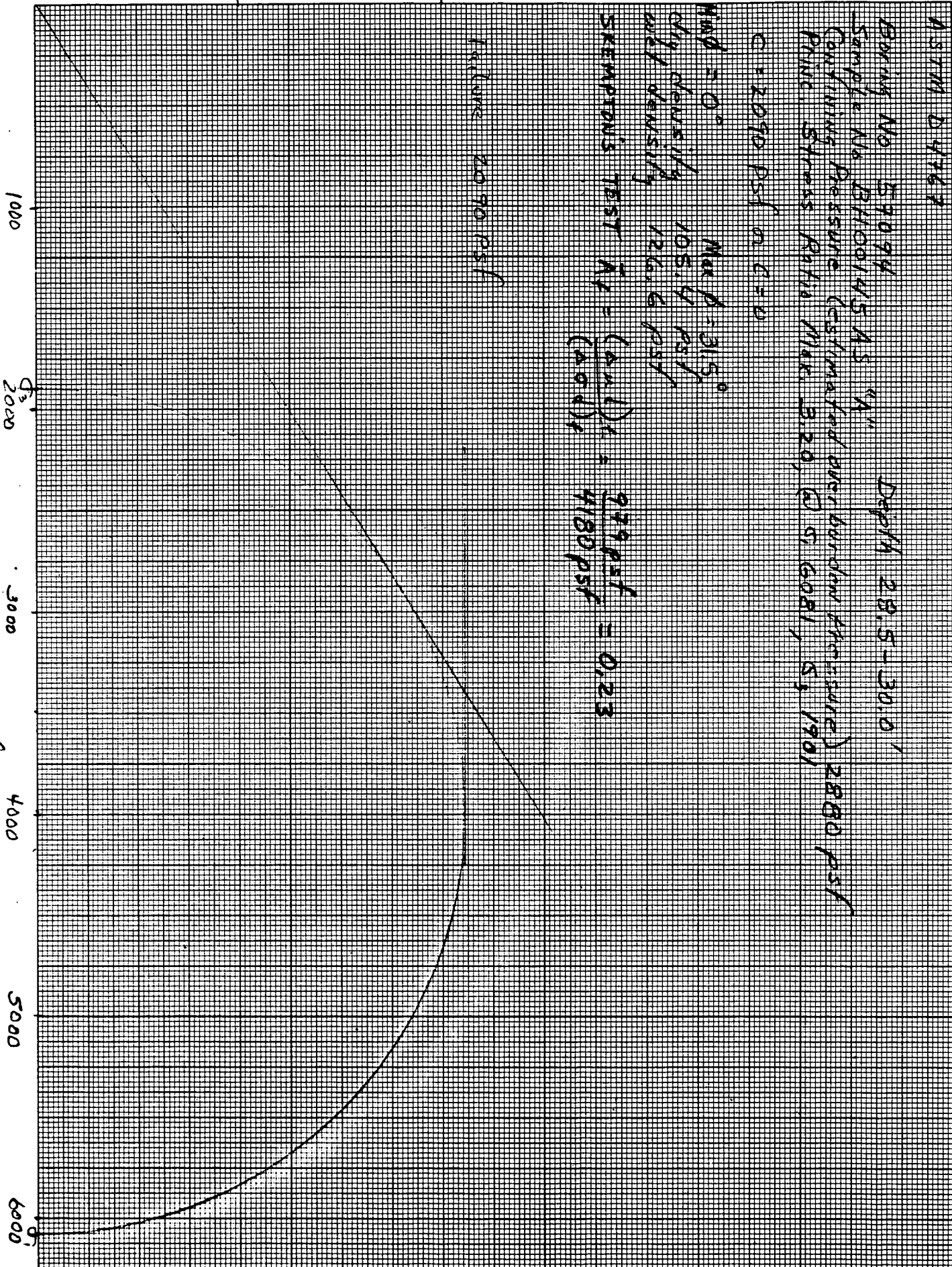
$$\frac{(4000) + (2800)}{2} = 3400 \text{ psf}$$

$$\frac{3400}{2800} = 1.214$$

$$\frac{1.214 - 1}{1.214} = 0.176$$

T psf

Failure 2090 psf



Triaxial Compression Data P 149

ASTM D 4767

Boring No. 51094

Depth 28.5 - 30'

Sample No. BH00143A5.6

Confining Pressure (estimated overburden pressure) 4320 psf

Princ. Stress Ratio Max = 2.89 (σ_1 7330, σ_3 2534)

$C = 2398$ psf $c/c' = 0$

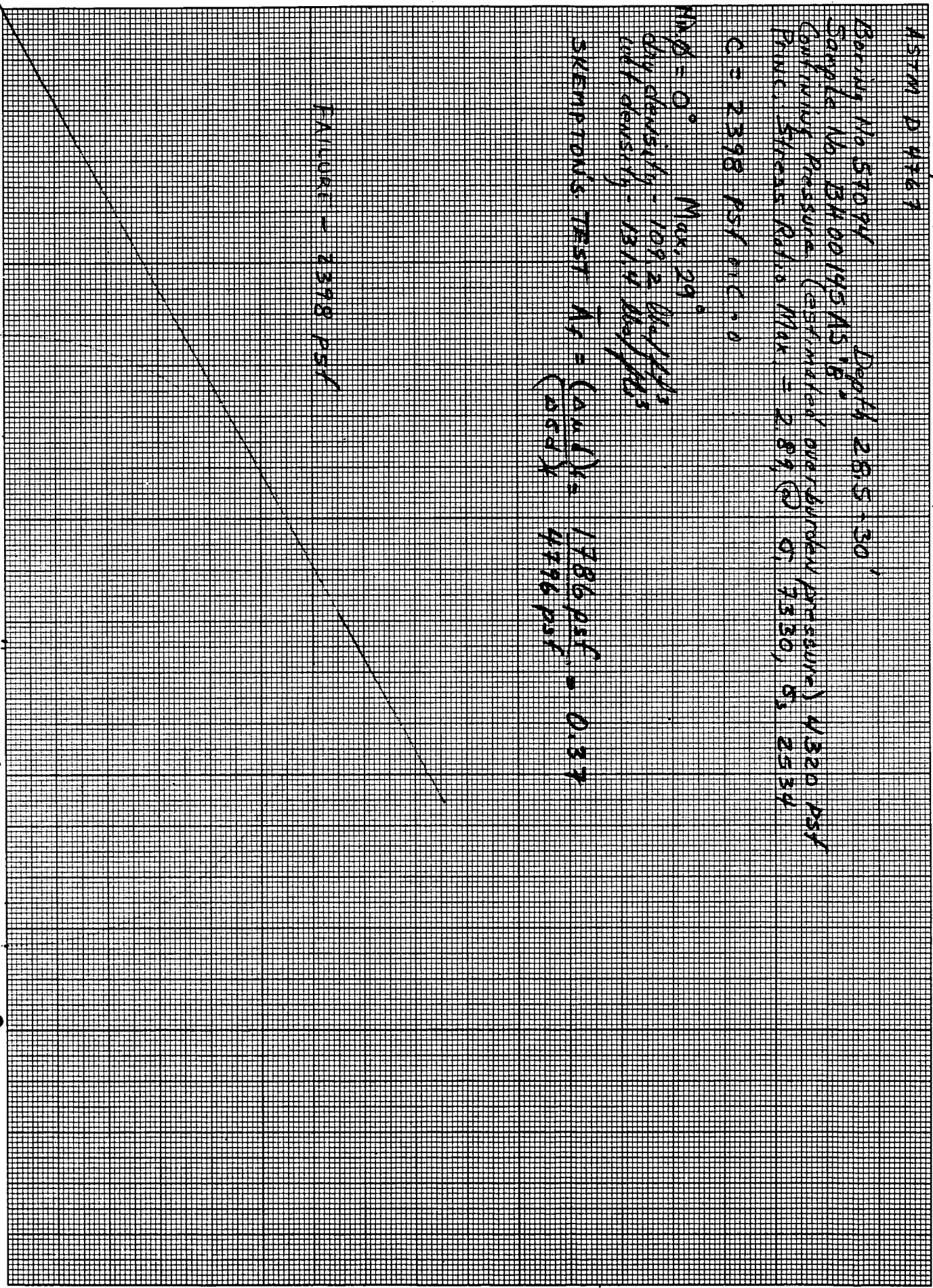
$\phi = 0^\circ$ Max. 29°

Dry density = 109.2 lb/ft³

Wet density = 131.4 lb/ft³

$$\text{SKEMPON'S TEST } A_1 = \frac{(A_1/I) \times 1786 \text{ psf}}{(2534) \times 4796 \text{ psf}} = 0.37$$

FAILURE - 2398 psf



ASTM D 4767

Boiling No. 57094

Depth 28.5 + 30.0'

Sample No. BH00145A5

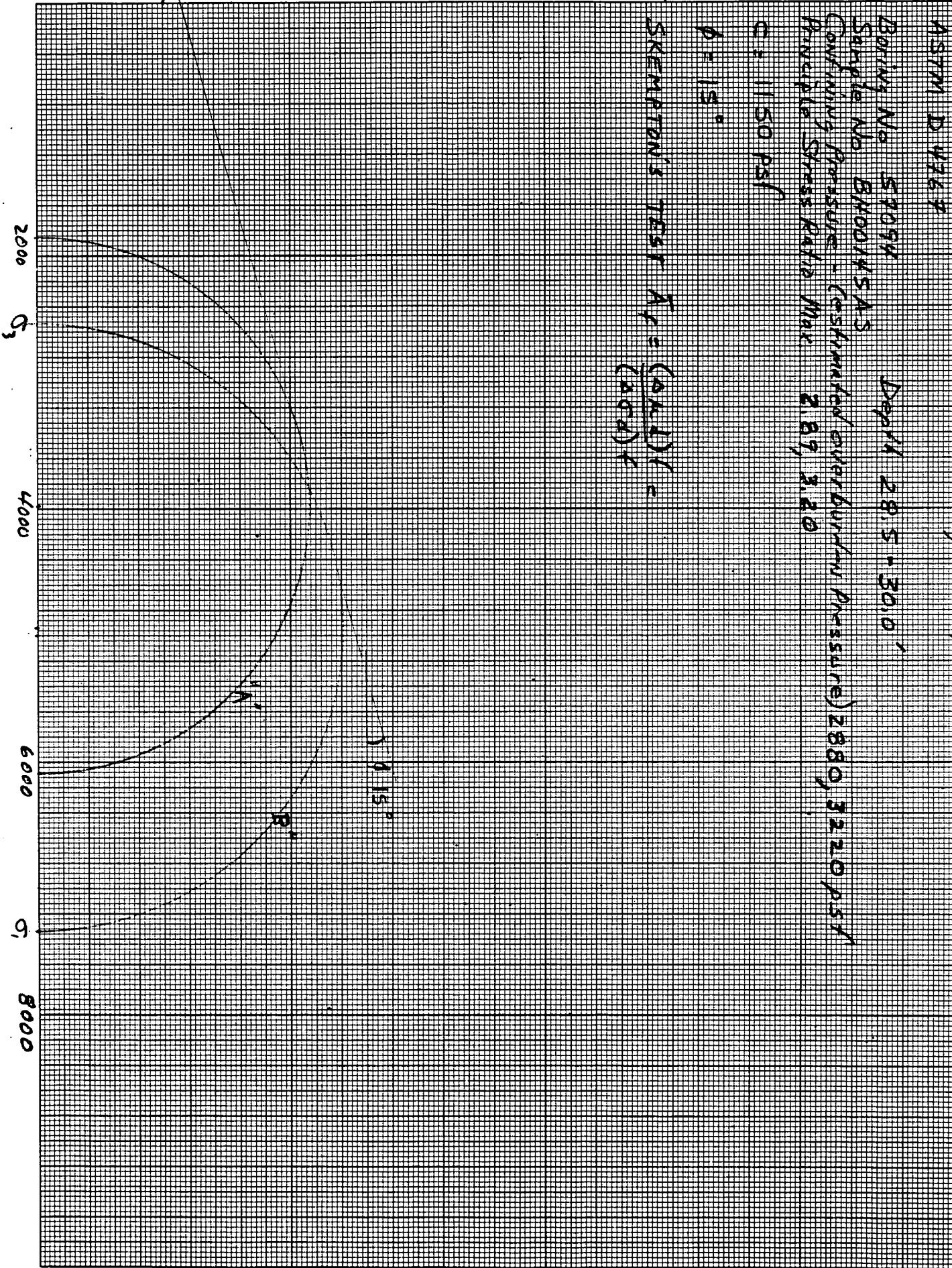
Confining Pressure - (Estimated overburden Pressure) 2880, 3220 psf

Principal Stress Ratio Max 2.89, 3.20

$C = 1150$ psf

$\phi = 15^\circ$

$$\text{SKEMPTON'S TEST } \lambda_1 = \frac{(\sigma_1 + C)}{(\sigma_3 + C)}$$



TRIAXIAL COMPRESSION DATA P 154

ASTM D 4967

Series No. 57694

Depth 6-8'

Sample No. BH 0019845

Confining Pressure (estimated overburden pressure) 720 PSF

Princ. Stress Ratio Max. = 4.85, @ σ_1 1535, σ_3 317

$C = 609$ PSF

$\phi = 0^\circ$ $\phi = 40.3^\circ$

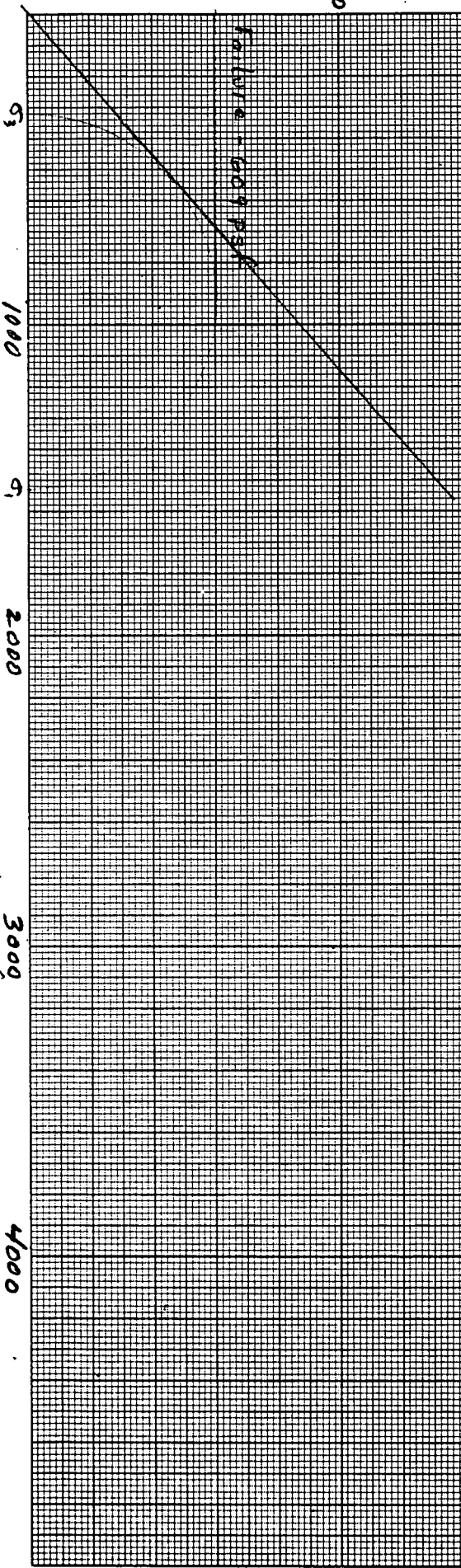
dry density 100.5 lb/cu ft

wet density 123.2 lb/cu ft

SKEMPTON'S TEST

$$A_1 = \frac{(609)(1)}{(200)(1)} = \frac{403.05}{1218} = 0.33$$

Failure = 609 PSF



T PSF

2000

1000

0 PSF

3000

4000

TRIAXIAL COMPRESSION DATA P 159

ASTM D-4764

Boring No. 57674

Depth 8-10'

Sample No. B10019945

Confining Pressure (estimated overburden pressure) 1440 psf

Princ. Stress Axis Max 3.24, @ σ 26/3, σ_3 806

$C = 903.5$ psf

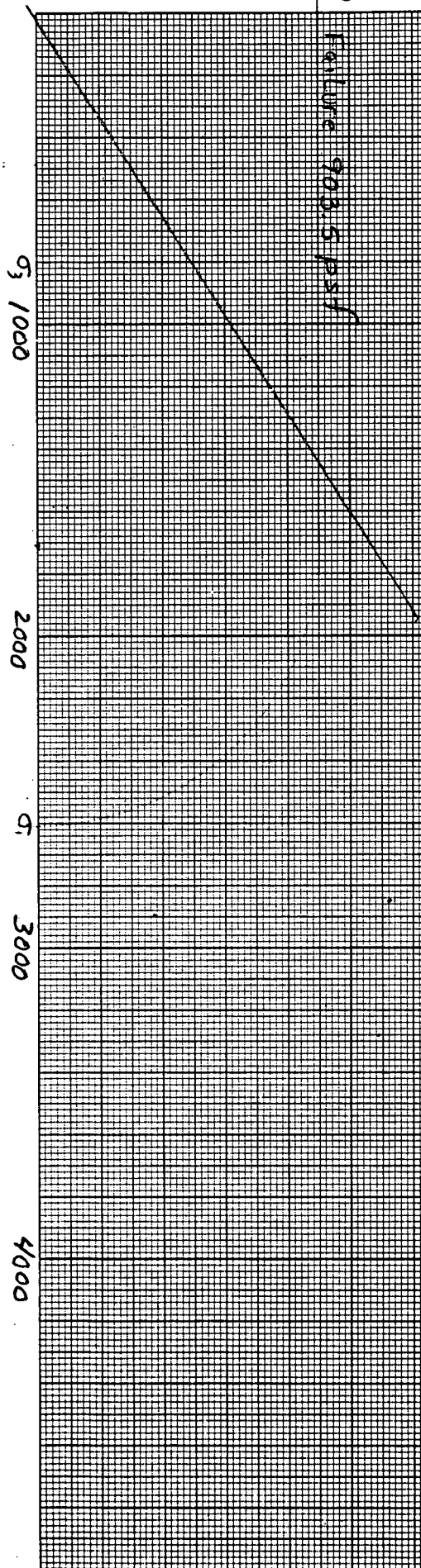
$\phi = 0^\circ$ $\mu = 32^\circ$

dry density 101 lb/ft³

wet density 123 lb/ft³

$$\text{SKEMPTON'S TEST } \bar{\sigma}_f = \frac{(2\Delta\sigma)_f}{(2\sigma_3)_f} = \frac{634 \text{ psf}}{1802 \text{ psf}} = 0.35$$

Failure 903.5 psf



TRIAXIAL COMPRESSION DATA P 164

ASTM D4967

Boring No. 57674

Depth 12-14'

Sample No. BH 0020045

Confining Pressure (estimated overburden Pressure) 2160 psf

Princ. Stress Ratio Max. 2.66, @ σ_1 3297, σ_3 1238

$C = 1029.5$ psf

$\phi = 0^\circ$ $\rho = 27.5^\circ$
dry density
and density

$$\text{SKEMPTON'S TEST } \bar{\sigma}_f = \frac{(\sigma_1 + 1) \sigma_3}{(\sigma_3 + 1) \sigma_1} = \frac{922 \text{ psf}}{2057 \text{ psf}} = 0.44$$

1000

Failure 1029.5 psf

2000

1000 σ_3

2000

3000

σ_1

4000

0 psf

TRIAXIAL COMPRESSION TEST DATA PAGES 154, 159, and 164

ASTM D-4962

3000

Soil Number 57491 Depth 6'-8", 8'-10", and 12'-14" Apparatus / Slide Mechanism
Sample Number BN 0019845, BN0019945, and BN 0020045
Confined Pressure: 920 PSI, 1440 PSI, 2160 PSI
Unconfined Stress Ratio MAX = 4.05 (0.1535) 224 (0.5 2413 01, 6004, 8, 6610, 9, 3109, 9, 1038

C = 360 PSI

$\sigma_1 = 10'$

2000

1000

1000

2000

3000

4000

TRIAXIAL COMPRESSION TEST P 189

ASTM D 4767

Boring No. 59594 Depth 24-26.5

Sample No. BH00135 AS (G)

Containing Preserved (Estimated/Overburden Pressure) 5040 psf

Drain Stress Ratio (Max. 6.21, @ 57505, 531210

C=31405 psf

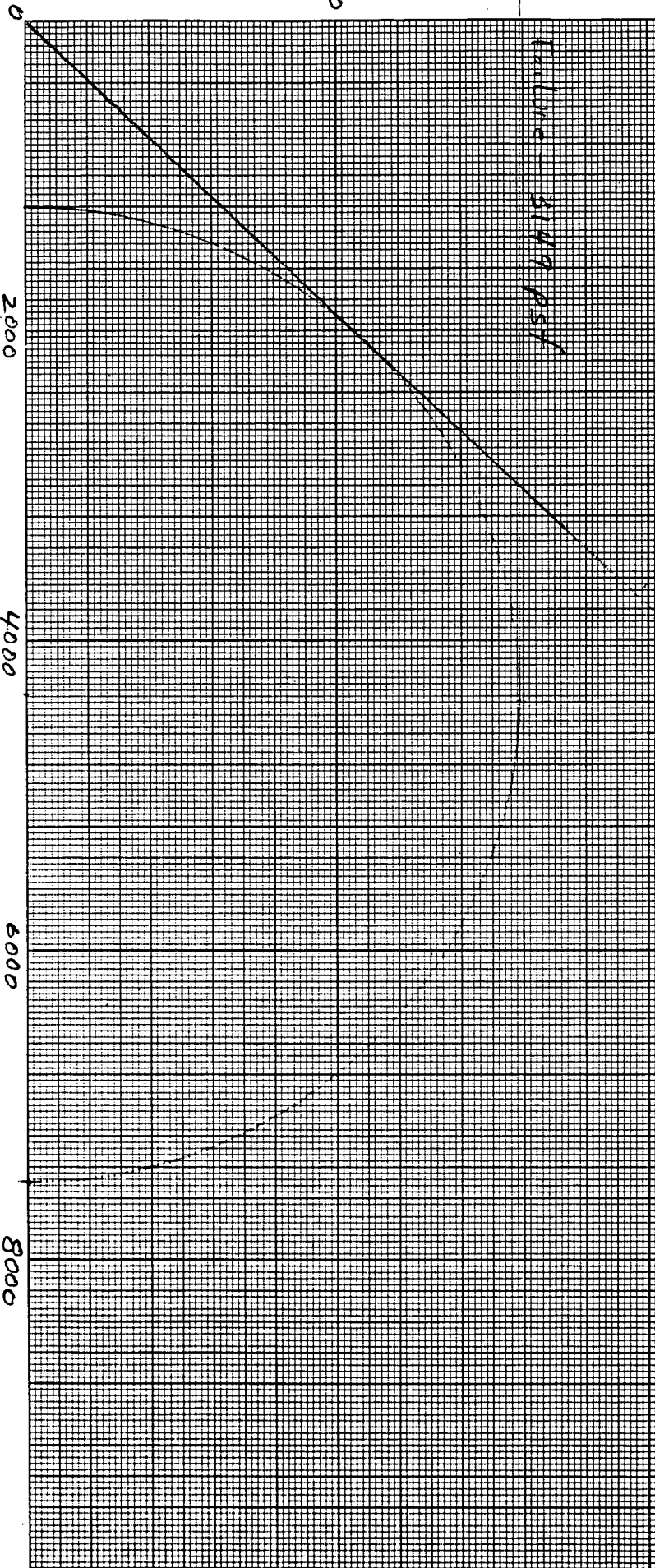
$\phi = 0^\circ$ $\phi_{avg} = 0^\circ$

Dry Density 119.0 lb./ft.³

Wet Density 129.2 lb./ft.³

Skempton's Test $\sigma_1 = (0.00) \times \frac{3830 \text{ psf} \times 1.6}{6295 \text{ psf}} = 0.97$

Failure 5149 psf



2000

T psf

4000

0 psf

TRIAxIAL COMPRESSION DATA

P 184

ASTM D 4267

Boring No. 59594

Depth 240 - 26.5'

Sample No. B100135 AS "A"

Conf. Pressure (Estimated Overburden Pressure) 7200 psf

Princ. Stress Ratio Max 3.43/100 11,494, 03 8355

C = 4069.5 ACIO

$\phi = 0^\circ$ $\tan \phi = 0.33^\circ$

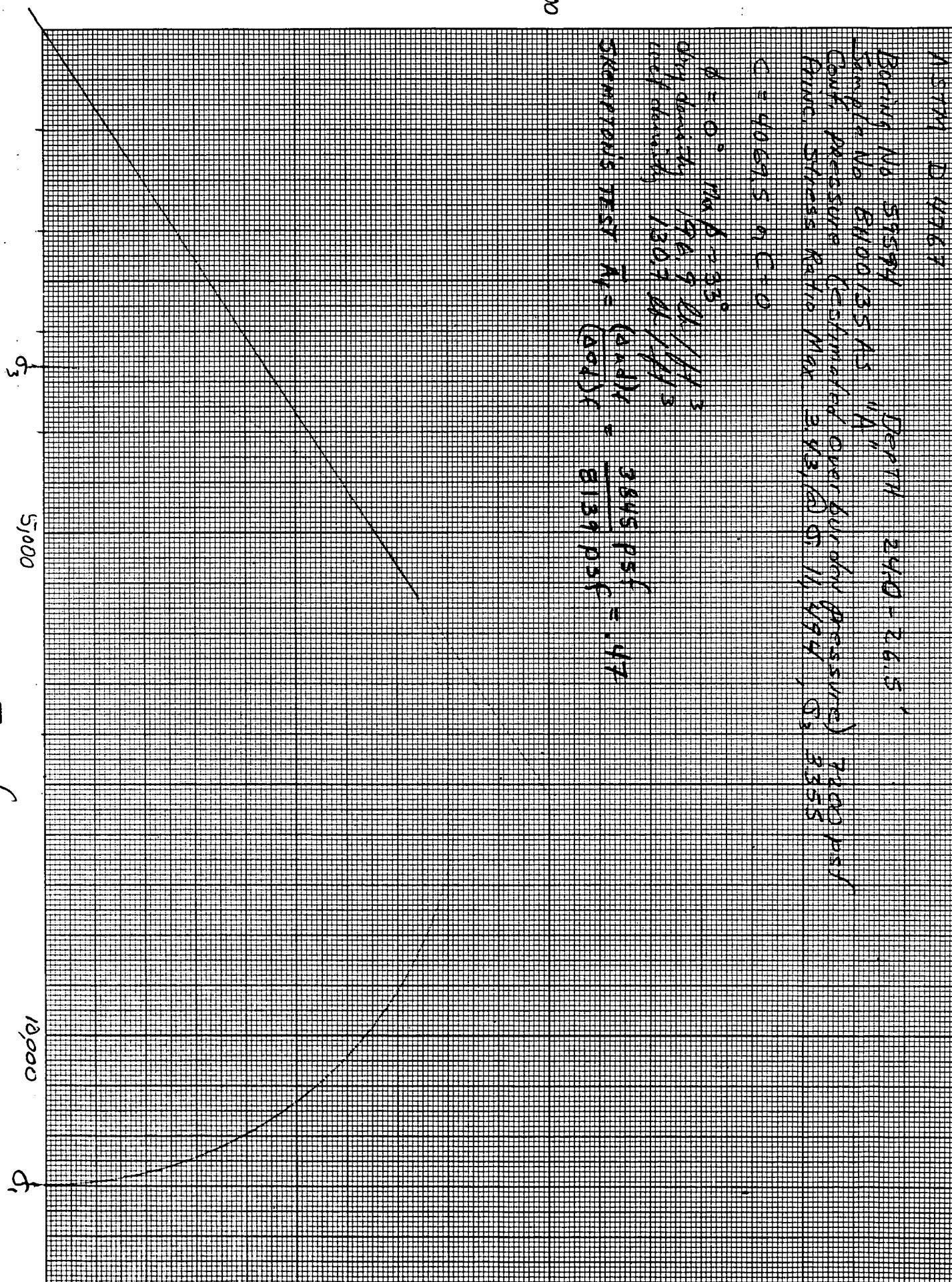
dry density 126.9 lb/ft³

wet density 130.7 lb/ft³

Skeletons test $A_1 = (2nd) = 3845 \text{ psf} = .47$
 $(2nd) = 8139 \text{ psf}$

5,000

T. Psf



TRIAXIAL COMPRESSION DATA D 194

ASTM D4967

Boring No. 5954 Depth 24.0 - 26.5

Sample No. BH 00135 AS 6C

Confining Pressure (estimated overburden pressure) 3600 psf

Actual Stress Ratio Max. 3.40, @ 5727, σ_1 1685

$C = 2021$ psf

$\phi = 0^\circ$ $\phi = 33^\circ$

dry density 111.0 lb/cu ft

wet density 121.5 lb/cu ft

Skempton's Test $A_r = \frac{(p_u - d)}{(p_u - d)} = \frac{1915 \text{ psf}}{4042 \text{ psf}} = .47$

τ psf

2000

4000

Failure 2021 psf

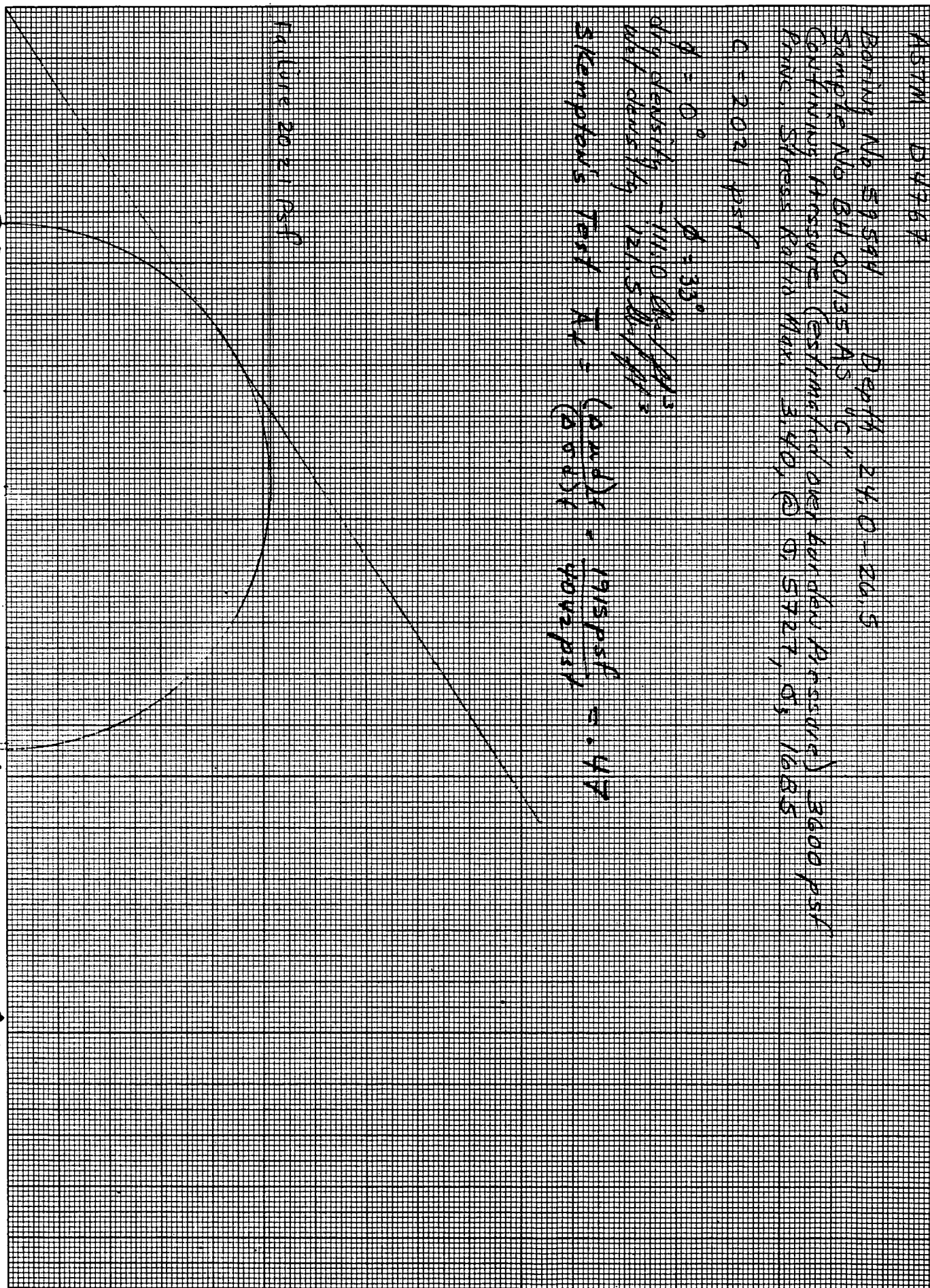
σ_3 2000

4000

6000

8000

5 psf



TRIAXIAL COMPRESSION DATA

184, 187, 194

ASTM D 4763

Booring No. 59594

Sample No. DM0013545 "A, B, C"

Conf. pressure (cell fluid and overburden pressures) 7200, 5040, 3600 psi

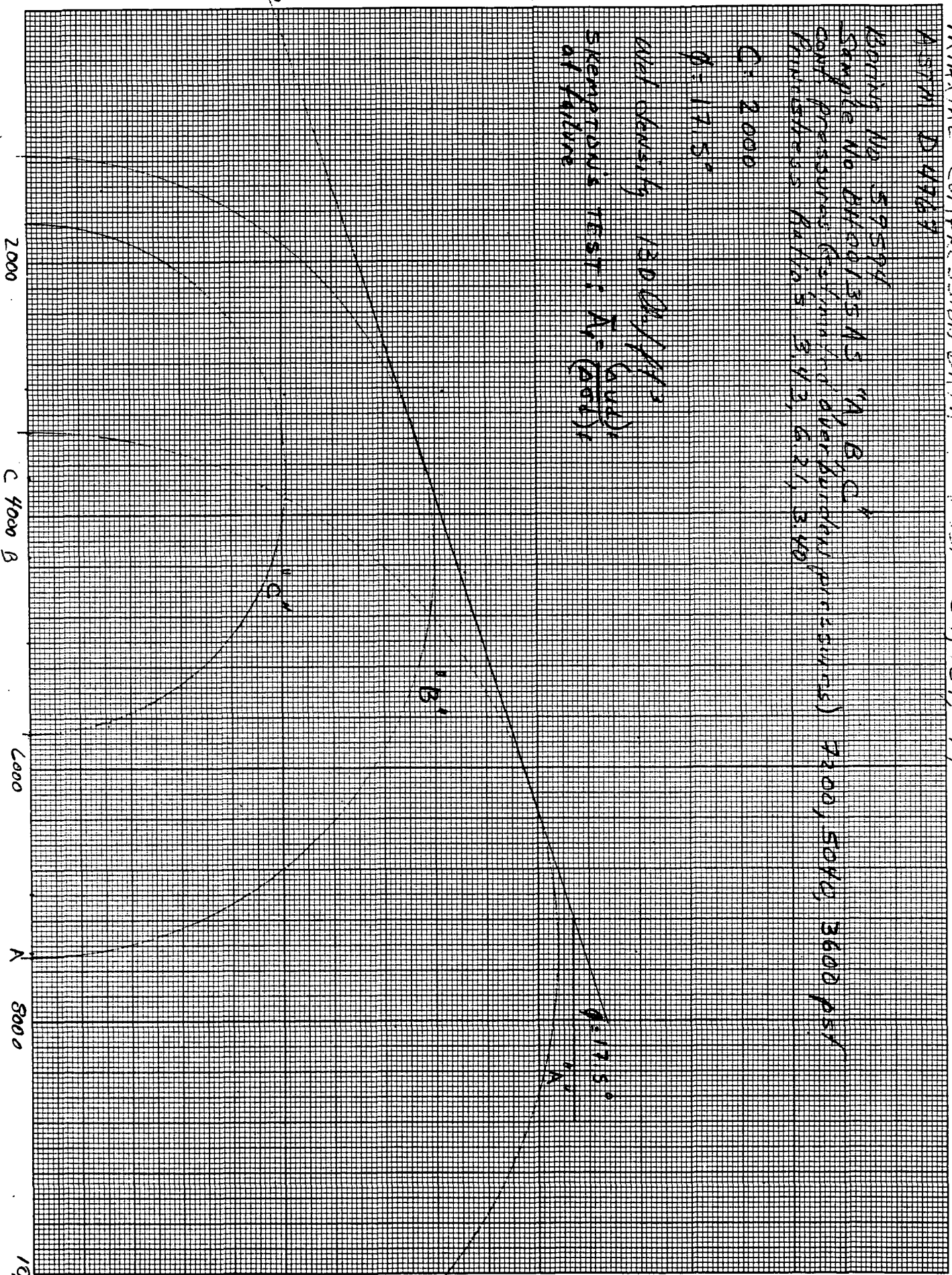
Failure values 3,413, 6,211, 8,440

C = 2000

$\phi = 17.5^\circ$

Wet density 130 lb/ft³

Skempston's test: $A_v = \frac{(p_{vd})}{(p_{cd})}$ at failure



psf
1200

4000

COMPOSITE TRIAXIAL SHEAR TESTS FOR WEATHERED UPPER ARAPAHO

ASTM 4388

Sample No.	1129	1130	1131	1132	1133	1134	1135	1136	1137	1138	1139	1140	1141	1142	1143	1144	1145	1146	1147	1148	1149	1150	1151	1152	1153	1154	1155	1156	1157	1158	1159	1160	1161	1162	1163	1164	1165	1166	1167	1168	1169	1170	1171	1172	1173	1174	1175	1176	1177	1178	1179	1180	1181	1182	1183	1184	1185	1186	1187	1188	1189	1190	1191	1192	1193	1194	1195	1196	1197	1198	1199	1200	1201	1202	1203	1204	1205	1206	1207	1208	1209	1210	1211	1212	1213	1214	1215	1216	1217	1218	1219	1220	1221	1222	1223	1224	1225	1226	1227	1228	1229	1230	1231	1232	1233	1234	1235	1236	1237	1238	1239	1240	1241	1242	1243	1244	1245	1246	1247	1248	1249	1250	1251	1252	1253	1254	1255	1256	1257	1258	1259	1260	1261	1262	1263	1264	1265	1266	1267	1268	1269	1270	1271	1272	1273	1274	1275	1276	1277	1278	1279	1280	1281	1282	1283	1284	1285	1286	1287	1288	1289	1290	1291	1292	1293	1294	1295	1296	1297	1298	1299	1300	1301	1302	1303	1304	1305	1306	1307	1308	1309	1310	1311	1312	1313	1314	1315	1316	1317	1318	1319	1320	1321	1322	1323	1324	1325	1326	1327	1328	1329	1330	1331	1332	1333	1334	1335	1336	1337	1338	1339	1340	1341	1342	1343	1344	1345	1346	1347	1348	1349	1350	1351	1352	1353	1354	1355	1356	1357	1358	1359	1360	1361	1362	1363	1364	1365	1366	1367	1368	1369	1370	1371	1372	1373	1374	1375	1376	1377	1378	1379	1380	1381	1382	1383	1384	1385	1386	1387	1388	1389	1390	1391	1392	1393	1394	1395	1396	1397	1398	1399	1400	1401	1402	1403	1404	1405	1406	1407	1408	1409	1410	1411	1412	1413	1414	1415	1416	1417	1418	1419	1420	1421	1422	1423	1424	1425	1426	1427	1428	1429	1430	1431	1432	1433	1434	1435	1436	1437	1438	1439	1440	1441	1442	1443	1444	1445	1446	1447	1448	1449	1450	1451	1452	1453	1454	1455	1456	1457	1458	1459	1460	1461	1462	1463	1464	1465	1466	1467	1468	1469	1470	1471	1472	1473	1474	1475	1476	1477	1478	1479	1480	1481	1482	1483	1484	1485	1486	1487	1488	1489	1490	1491	1492	1493	1494	1495	1496	1497	1498	1499	1500	1501	1502	1503	1504	1505	1506	1507	1508	1509	1510	1511	1512	1513	1514	1515	1516	1517	1518	1519	1520	1521	1522	1523	1524	1525	1526	1527	1528	1529	1530	1531	1532	1533	1534	1535	1536	1537	1538	1539	1540	1541	1542	1543	1544	1545	1546	1547	1548	1549	1550	1551	1552	1553	1554	1555	1556	1557	1558	1559	1560	1561	1562	1563	1564	1565	1566	1567	1568	1569	1570	1571	1572	1573	1574	1575	1576	1577	1578	1579	1580	1581	1582	1583	1584	1585	1586	1587	1588	1589	1590	1591	1592	1593	1594	1595	1596	1597	1598	1599	1600	1601	1602	1603	1604	1605	1606	1607	1608	1609	1610	1611	1612	1613	1614	1615	1616	1617	1618	1619	1620	1621	1622	1623	1624	1625	1626	1627	1628	1629	1630	1631	1632	1633	1634	1635	1636	1637	1638	1639	1640	1641	1642	1643	1644	1645	1646	1647	1648	1649	1650	1651	1652	1653	1654	1655	1656	1657	1658	1659	1660	1661	1662	1663	1664	1665	1666	1667	1668	1669	1670	1671	1672	1673	1674	1675	1676	1677	1678	1679	1680	1681	1682	1683	1684	1685	1686	1687	1688	1689	1690	1691	1692	1693	1694	1695	1696	1697	1698	1699	1700	1701	1702	1703	1704	1705	1706	1707	1708	1709	1710	1711	1712	1713	1714	1715	1716	1717	1718	1719	1720	1721	1722	1723	1724	1725	1726	1727	1728	1729	1730	1731	1732	1733	1734	1735	1736	1737	1738	1739	1740	1741	1742	1743	1744	1745	1746	1747	1748	1749	1750	1751	1752	1753	1754	1755	1756	1757	1758	1759	1760	1761	1762	1763	1764	1765	1766	1767	1768	1769	1770	1771	1772	1773	1774	1775	1776	1777	1778	1779	1780	1781	1782	1783	1784	1785	1786	1787	1788	1789	1790	1791	1792	1793	1794	1795	1796	1797	1798	1799	1800	1801	1802	1803	1804	1805	1806	1807	1808	1809	1810	1811	1812	1813	1814	1815	1816	1817	1818	1819	1820	1821	1822	1823	1824	1825	1826	1827	1828	1829	1830	1831	1832	1833	1834	1835	1836	1837	1838	1839	1840	1841	1842	1843	1844	1845	1846	1847	1848	1849	1850	1851	1852	1853	1854	1855	1856	1857	1858	1859	1860	1861	1862	1863	1864	1865	1866	1867	1868	1869	1870	1871	1872	1873	1874	1875	1876	1877	1878	1879	1880	1881	1882	1883	1884	1885	1886	1887	1888	1889	1890	1891	1892	1893	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100	2101	2102	2103	2104	2105	2106	2107	2108	2109	2110	2111	2112	2113	2114	2115	2116	2117	2118	2119	2120	2121	2122	2123	2124	2125	2126	2127	2128	2129	2130	2131	2132	2133	2134	2135	2136	2137	2138	2139	2140	2141	2142	2143	2144	2145	2146	2147	2148	2149	2150	2151	2152	2153	2154	2155	2156	2157	2158	2159	2160	2161	2162	2163	2164	2165	2166	2167	2168	2169	2170	2171	2172	2173	2174	2175	2176	2177	2178	2179	2180	2181	2182	2183	2184	2185	2186	2187	2188	2189	2190	2191	2192	2193	2194	2195	2196	2197	2198	2199	2200	2201	2202	2203	2204	2205	2206	2207	2208	2209	2210	2211	2212	2213	2214	2215	2216	2217	2218	2219	2220	2221	2222	2223	2224	2225	2226	2227	2228	2229	2230	2231	2232	2233	2234	2235	2236	2237	2238	2239	2240	2241	2242	2243	2244	2245	2246	2247	2248	2249	2250	2251	2252	2253	2254	2255	2256	2257	2258	2259	2260	2261	2262	2263	2264	2265	2266	2267	2268	2269	2270	2271	2272	2273	2274	2275	2276	2277	2278	2279	2280	2281	2282	2283	2284	2285	2286	2287	2288	2289	2290	2291	2292	2293	2294	2295	2296	2297	2298	2299	2300	2301	2302	2303	2304	2305	2306	2307	2308	2309	2310	2311	2312	2313	2314	2315	2316	2317	2318	2319	2320	2321	2322	2323	2324	2325	2326	2327	2328	2329	2330	2331	2332	2333	2334	2335	2336	2337	2338	2339	2340	2341	2342	2343	2344	2345	2346	2347	2348	2349	2350	2351	2352	2353	2354	2355	2356	2357	2358	2359	2360	2361	2362	2363	2364	2365	2366	2367	2368	2369	2370	2371	2372	2373	2374	2375	2376	2377	2378	2379	2380	2381	2382	2383	2384	2385	2386	2387	2388	2389	2390	2391	2392	2393	2394	2395	2396	2397	2398	2399	2400	2401	2402	2403	2404	2405	2406	2407	2408	2409	2410	2411	2412	2413	2414	2415	2416	2417	2418	2419	2420	2421	2422	2423	2424	2425	2426	2427	2428	2429	2430	2431	2432	2433	2434	2435	2436	2437	2438	2439	2440	2441	2442	2443	2444	2445	2446	2447	2448	2449	2450	2451	2452	2453	2454	2455	2456	2457	2458	2459	2460	2461	2462	2463	2464	2465	2466	2467	2468	2469	2470	2471	2472	2473	2474	2475	2476
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Unconfined Compressive Strength Test Data P 48.

ASTM D 2166 At Field Moisture

Corrus N 57094

Sample No BH00138A5

Confining Pressure 0

Signs 1 max 3379

1690 p.s.f. maximum cohesion

τ p.s.f

2000

1000

0

1000

2000

3000

0

4000

σ p.s.f

DIETZGEN CORPORATION
MADE IN U.S.A.

NO. 341-M DIETZGEN GRAPH PAPER
MILLIMETER

Unconfined Compressive Strength Test Data PSI

ASTM D 2166

At Field Moisture

Barrel No 57544
Sample No BH0019545

Signa 1 max 1411

706 psl maximum cohesion

T Psf

2000

1000

0

1000

0

2000

3000

5 psl

DIETZGEN CORPORATION
MADE IN U. S. A.

NO. 341-M DIETZGEN GRAPH PAPER
MILLIMETER

UNCONFINED COMPRESSIVE STRENGTH Test Data P 54

ASTM D 2166 AT FIELD MOISTURE

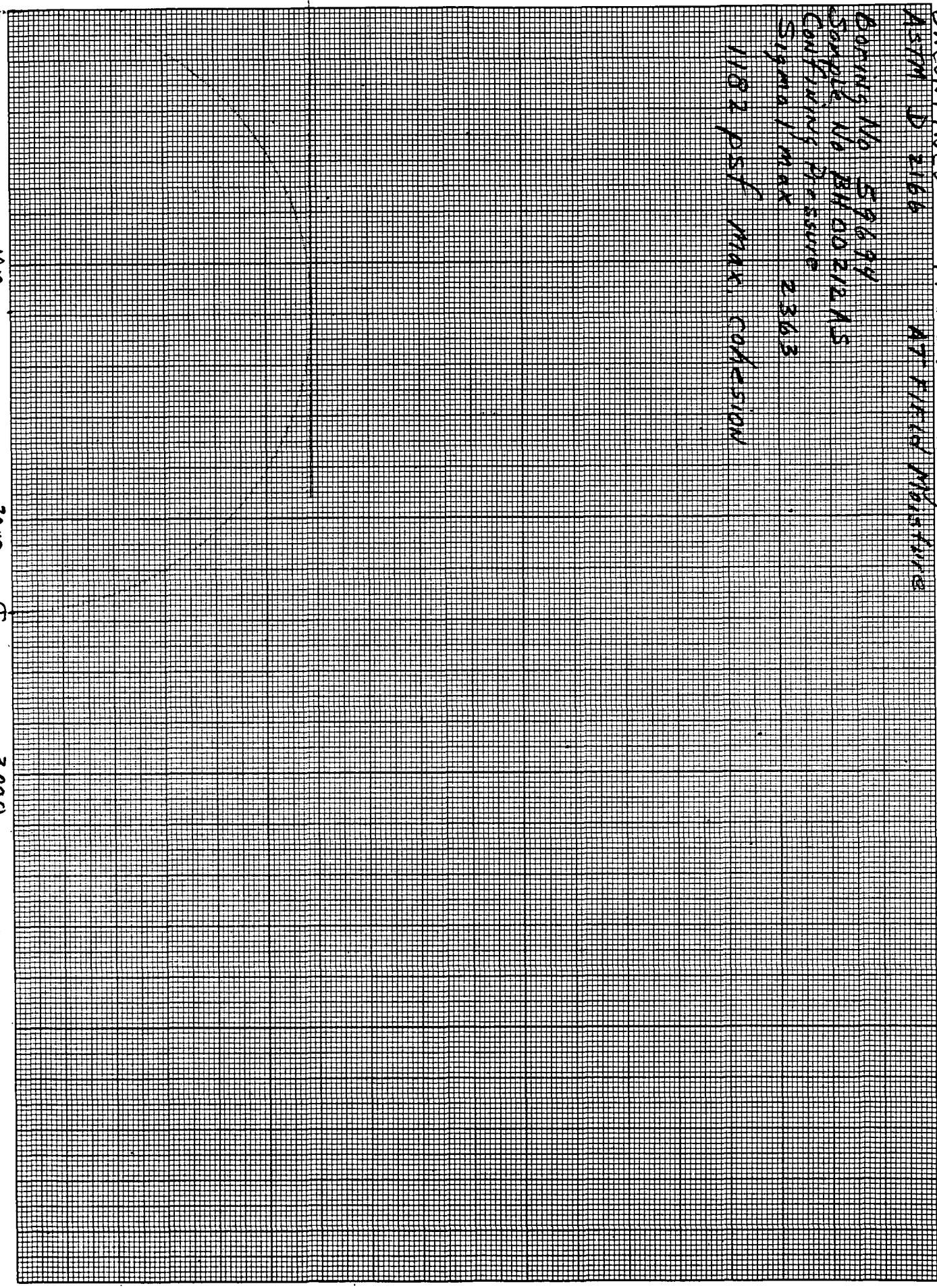
Coring No. 59699

Sample No. BH00212AS

Confining Pressure

Sigma 1 max 2363

1182 psf max. cohesion



Coring No. 59594
 Sample No. BH00135A5
 No. finer than 2mm, 40.4
 Plasticity Index, PI 40.4
 (Hydrometer) P 105

A = Activity

A = $\frac{PI}{20}$

70 of clay size fraction, by wt. < 2mm

$$A = \frac{40.4}{35.8}$$

A = 1.13

Considered a medium clay with an
 1911 Koble to 1800 with 1911

A = 1.13

PI

200

100

20 40 60 80 100

70 of clay size < 2mm

Boring No. 59694
 Sample No. BH00215A3
 90 ft. from bottom by wt. 16.7% (Hydrometer)
 Plasticity Index, PI 32.3 P 35 P 102

A = Activity

$A = \frac{PI}{\% \text{ of clay size fraction, by wt. (2.0 mm)}}$

$$A = \frac{32.3}{16.7}$$

$$A = 1.93$$

Considered an active clay with a
 40% kaolinite/bentonite mixture

$$A = 1.93$$

20 40 60 80

100
 200
 PI

Sample No. 57994
 Sample No. BH00118 AS
 No. of dry size fraction, by wt.
 40.6% (Hydrometer) p 36
 33.0 p 36

$A = \text{Activity}$

$A = \frac{PI}{\% \text{ of clay size fraction, by wt. (exam.)}}$

$$A = \frac{33.0}{40.6}$$

$$A = 0.81$$

Consider a mound of clay with a
 20:1 horizontal to 1 vertical ratio

$$A = 0.81$$

20 40 60 80 100

200
 PI
 100

Boring No. 31194
 Sample No. BH0010345
 No. from 20mm, by weight 50.6% (Hydrometric) P 114
 Plasticity Index, PI 44.2 P 38

$A = \text{Activity}$

$A = \frac{PI}{25}$

70% clay size fraction by wt. (2mm)

$A = \frac{44.2}{50.6}$

$A = 0.87$

Considered a marginal clay with
 2011 Koelnite / Barboite mixture

$A = 0.87$

20 40 60 80

100

PI

200

Boiling 10g 59.594
 Sample 10g 51100 13415
 1/2 liter 100g 100g 1170 (Hydrometer) P102
 Activity Index, PI 20.3 P32

A = Activity

A = $\frac{PI}{\% \text{ of clay size fraction by wt.}} \times 100$

$$A = \frac{20.3}{11}$$

$$A = 1.85$$

Considered an active clay with an
 5:1 K_h limit / Bentonite mixture

$$A = 1.85$$

20

40

60

80

100

200

PI

BORING NO. 59394
 SAMPLE NO. 840017005
 No. from 1st 2mm. by weight 30.3% (Hydrometer) # 99
 Plasticity Index, PI = 31.6 P 29

A = Activity

$A = \frac{PI}{\% \text{ of clay imp. fraction, } p_{20} = 20}$

$A = \frac{31.6}{30.3}$

A = 1.04

Considered a normal clay with a
 14% K₂SiO₃ / 13% K₂CO₃ with 1% mixture

A = 1.04

Corning 116 54494
 Sample No. BH00173A5
 200 gms. Dry weight, 44.04 gms.
 100 gms. Wet weight, 49.9 gms.
 PI = 49.9 - 38.6 = 11.3 (Hydrometer) p 96

A = Activity

A = $\frac{PI}{\% \text{ of clay size fraction, hyd (2 um)}}$

A = $\frac{49.9}{38.6}$

A = 1.29

Considered as active clay with activity
 of 901 Kaolinite / Smectite mixture

A = 1.29

% of clay size fraction

DIETZEN CORPORATION
 MADE IN U.S.A.

NO. 341-M DIETZEN GRAPH PAPER
 MILLIMETER

PI

200

100

20

40

60

80

100

Coring No. 57094
 Sample No. CH00190A5
 of size (1/4) 3/4 by 1/4 (33.79% by diameter) p 84
 Plasticity Index, PI 29.2 p 20

A = ACTIVITY

A = PI

% of clay size fraction by wt, CLAY

A = $\frac{33.79}{33.79}$

A = 1.16

Confirmed a normal clay with an
 activity of 1.16 (Portland/Boulderite)

A = 1.16

90 of Clay

100

200

PI

Corrug No 570 94
 Sample No BH 00142 A-5
 96 inch Max 2 mm 6 g weight 6.47% (Hydrometric) p 90
 Plasticity Index PI 35.1 p 21

$$A = A_{clay} / 100$$

$$A = \frac{PI}{\% \text{ of clay size fraction, by wt.}}$$

$$A = \frac{35.1}{6.4}$$

$$A = 5.48$$

Considered a highly active clay
 with one activity of commercial
 bentonite

$$A = 5.48$$

20

40

60

80

100

PI

200

100

Plasticity Index

200

100

Boring No. 57094
 Sample No. 840013845
 75% from 4mm 2 mm by weight
 Plasticity Index PI 12.4
 18.4% (by diameter) page 81

A_s Activity

A_s $\frac{PI}{\% \text{ clay size fraction, by weight}}$

A = $\frac{27.4}{18.4}$

A = 1.49

Considered an active clay with a 98%
 Kaolinite/illite structure

A = 1.49

20

40

60

80

% of Clay Size Fraction (< 2mm)

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 MILLIMETER

Boring No 56994
 Sample No BH0018815
 2.5 mm, by weight 6.7% (App. diameter) page 78
 Plasticity index, PI 25 p 17

A = Activity

A = $\frac{PI}{25}$

70% clay size fraction, by weight < 2mm

A = $\frac{25}{6.7}$

A = 3.6225

Considered as active clay with a
 1.5:1 K_u limit / Bentonite mixtures

A = 3.6

PI

100

Percentage of Clay Size Fraction (< 2mm)

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 MILLIMETER

20 40 60 80 100

NO. 341-M DIETZGEN GRAPH PAPER
MILLIMETER

Appendix 4

Subsurface Geology Data

ATTERBERG
LL RI -200 SIEVE

MOISTURE
DENSITY

TRIAXIAL DIRECT

UNCONF. OBSERVATIONS

18.2

0, 33°

0, 45.7°

0, 33°

Combined
Tests
C = 2000
φ = 19.5°
for
Rocky
Flats
Alluvium
Material 1.5

ROCKY FLATS ALLUVIUM

ARAPAHO

TD 41'

BOREHOLE 59594 (cont.)

(Page 21) Boring 59594

Location: Atop Rocky Flats Terrace toward west end of landfill;
just North of west side. 75' north of flat terrace edge.

Mobile B-57 drill

Boyles Brothers

Drill with 3.25" ID Hollow Stem Augers

Cal Mod Drive Sampling

Push 3" Shelbys

Moss System

Water first encountered at 32'; measured @ 29.5'

Drilled 12/8-9/94

TD 41'

Install Piezometer: screened from 37.6' to 27.6' (details on page 26)

Installed 12/14/94

(Page 22) Boring 59594 cont.

0'-0.1' Topsoil: roots, silt.

ROCKY FLATS ALLUVIUM

0.1'-0.5' SILTY GRAVEL (GM): dark
brn.; damp; f. - crs.; organics.

0.5'-22' SANDY, CLAYEY GRAVEL (GC)
yellowish, brown, reddish-brown;
damp-moist (fines); generally
appears dense (material is too
coarse for accurate PR from drive
sampling); f. to crs., subangular-
subrounded (mostly qtzite), occ.
cobbles; f. to crs. sand; clayey
sand (SC) from approx. 7' to 7.3'

GC, broken, angular* rock
(qtzite) with in greenish-gray,
moist clay (CL-CH), approx. 8.5-9'
*fragmented via sampling
traces moist-v. moist, greenish-
gray clay (CL-CH) from 8.5' to 22'
med. dense? clayey sand, f. to crs.
from approx. 10'-10.5'
Cobble (fragmented rock) from
10.5'-11'

0'-2' Moss

rec. 2.0/2.0

2'-2' Cal Mod

refusal (bouncing)

@ 2'

2'-4' Moss

rec. 1.5/2.0

(gravels pulverized by
drill action)

4'-6' Moss

rec. 1.3/2.0

Note: v. slow, grinding,
rough drilling from 0'-22'

6-8' Moss rec. 1.5/2.0

8.5'-8.9' Cal Mod

refusal 50/5" (retain
bag sample)*

8.9'-10' Moss

rec. 0.5/1.1

10'-11' Cal Mod

15/95/6"; refusal 11'

rec. 1.0/1.0

11'-12' Moss

rec. 1.0/1.0; bag sample

12'-14' Moss

rec. 1.6'/2.0'

(Page 23) 59594 cont.

0.5'-22' SANDY, CLAYEY-GRAVEL (cont)

14'-16' Moss

rec. 1.2/2.0

16'-18' Moss

rec. 1.4/2.0

18'-18.2' Cal Mod

60/2": refusal (bouncing)

rec. 3" cobble

Note: bulk sample, 0-22', contains pulverized rock (gravels pulverized by drilling action); appears finer grained than in place material.

22'-25' SANDY CLAY (CL-CH): yellowish, brown, some gray mottling moist; v. stiff, f.-crs. sand. hard below approx. 24' approx. 25'-26.5' CLAYEY SAND (SC): mottled gray, yellowish-brn.; moist; dense; f.-crs.; 30-40% mod. plastic fines

26.5'-32' SANDY CLAY (CL), some CLAYEY SAND (SC): yellow brown, some gray mottling; moist; v. stiff-hard; f.-crs. sand; occ. gravel and cobbles.

(Page 24) 59594 (cont.)

Weathered CLAYSTONE (displaced block?) from 31.3' to 32' (claystone is probably detrital; block is dry).

32'-35' poorly graded SAND, CLAYEY SAND (SP-SC): yellowish-brown; wet; dense-v. dense; f. grained.

35'-36' SANDY SILT (ML): gray-brn. mottled orange; wet; v. dense; v. f. sand;

36'-37.5' poorly graded SAND-CLAYEY SAND (SP-SC): as above, 32'-35' (*possibly slowly)

ARAPAHOE FORMATION

37.5'-37.8' CLAYSTONE/LEAN CLAY (CL): yellowish-brn., orange, gray (layered, mottled); damp-moist; hard. "Rock" Properties: highly weathered; plastic; soft.

37.8'-41' CLAYSTONE (CL): mottled gray/yellowish-brn.; mod. wthered.;

wedged in shoe.

18.2-20' Moss
rec. 1.0'-1.8'

20'-22' Moss
rec. 1.0/2.0

22'-24' Moss

rec. 2.0/2.0

pp=2.5 @ 23'

=4.0 @ 24'

24' 12/8, 12/9

retain bulk sample
of cuttings, 0-22'
(in metal bucket)

24'-26.5' push Shelby
rec. 2.4/2.5

pp=4.25 tsf @ 26.4'

26.5'-27.5' Cal Mod

28/60/6" refusal

27.5'-28' Moss*

rec. 0.5-0.5

28'-30' Moss

rec. approx. 1.2/2.0

pp=4.5 tsf @ 27'

30'-32' Moss

rec. 1.2/2.0

32'-34' Moss

rec. 2.0/2.0

wet @ 32'

34'-35' Cal Mod

*5/105/6"; refused

*5 blows probably

from clean sands that

flowed into the auger

35-35.8' SPT 38/50/3"

refused; rec. 0.8/0.8

retain bag sample

35.8-38' Moss

rec. 2.2/2.2

pp=4.5 @ 37.7'

38'-38.9' push Shelby

refusal

(6,000 psi down press.)

rec. 0.9/0.9; bent tube

38.9'-41' Moss

sampler stuck in augers;

broke wireline trying to pull;

trip out augers

rec. 0.5/2.0

(upper sampler packed with
slough)

(Page 26)

37.8'-41' CLAYSTONE (cont.); plastic

friable;soft;displays some thin laminations (iron and manganese stained bedding, sfcs., approx. horizontal). Soil Properties: damp;hard;lean clay (CL-"silty claystone"). Includes some v. f. silty-sandstone laminae.

Terminate @ 41'

Install monitoring well: 12/14/94
caved material, 41-40'

#16/40 sand, 40'-25.5'

Bentonite (pellets) 25.5'-23.5'

Bentonite grout slurry 23.5'-0'

2" Blank PVC 39.6'-37.6'

2" .010" slotted

PVC screen 37.6'-27.6'

2" Blank PVC 27.6'- surface

BOREHOLE 59594 LABORATORY SAMPLES

*BH00135AS, 59594 (page 296), 24-26.5'

25-29" CL, no test

21-25" CL

Atterberg Limits Test LL 56.2 PI 40.4

Grain Size Analysis

Hydrometer Test

15-21" CL

Triaxial Compression Test (pore pressure) $C_c = 0$ $\phi = 33$

9-15" CL

Triaxial Compression Test (pore pressure) $B_c = 0$ $\phi = 45.7$

3-9" CL

Triaxial Compression Test (pore pressure) $A_c = 0$ $\phi = 33$

1-3" CL

Consolidation Test

(2)

ATTERBERG
LL PI -200 SIEVE

MOISTURE TRIAXIAL DIRECT UNCONF OBSERVATIONS
DENSITY

3-4'

9.8%

20-25-15 AVG

42.1%

32

13.8%

$C=1182$

$\phi=0^\circ$

DIETZEN CORPORATION
MADE IN U.S.A.

7-9'

2-13'

13-15'

COLLUVIUM

13.7%

15.7% 116

← COLLUVIUM
← KARAPAND FM
← KARAPAND FM
← KARAPAND FM

TD-20

NO. 341-M DIETZEN GRAPH PAPER
100 MILLIMETER

BOREHOLE 59694

Middle of slide w/ 50%

(Page 102) Boring 59694.

Location: 20' north of SID, toward west end of landfill; just south of "west slide" toe.

Mobile B-57

Boyles Brothers

Advanced hole with 3.25" ID Hollow Stem Augers

3" Shelby Tubes

Moss Sampling

Cal Mod drive sampling

free water (in hole) not encountered; wet soil (traces of free water in sample. Observed from 10'-15.5'.

drilled 2/3/95

Install Well 2/3/95:

20'-18': Bentonite Pellets

18'-14': 16/40 sand

4'-2': Bentonite Pellets

2'-0': grout bentonite

18'-16': 2" PVC blank (sump)

16'-6': 2" slotted PVC (.010")

6': surface blank PVC

(Page 103) Boring 59694

FILL

0'-1.8' GRAVELLY, SANDY CLAY (CL): rec. 2.0/2.0

dark brn.; moist; roots to 1'.

1.8'-13' SANDY, CLAYEY GRAVEL (GC): 44/50/4"; rec. 0.8/0.8

orange-brn., mod. brn.; damp; dense; drill out to 3'

f.-crs. sand, gravel; occ. roots.

moist below 4'

mixed gray, orange-brn. below 5.5'

med. dense (clay matrix appears

soft-firm) from 6'-12';

v. moist from 6'-10'

possible mixed colluvium/slide?

from 11'-13'

wet below 10'

sandy clay with gravel (CL), stiff

(? appears softer) from 11'-11.7'

loose from 12'-13'

0'-2' Moss

2'-2.8' Cal Mod

3'-5' Cal Mod

35/65/48/38; bag samp.

3'-4'; rec. 1.6/2.0

5'-7' Cal Mod

21/32/25/16

rec. 2.0/2.0

7'-9' push Shelby

rec. 2.0/2.0

push up to 4000#

bottom 0.1' dented

9'-11' Cal Mod

6/13/19/16

rec. 1.8/2.0

11'-13' Cal Mod

9/14/10/9; bag samp.

12'-13'; rec. 1.8/2.0

13'-15' push Shelby

easy push; rec. 1.1/2.0

15'-17' Cal Mod

*13/16/19/26

rec. 2.0/2.0

sample disturbed (pushing

a rock elevated blows?)

from 13'-14'

COLLUVIUM/SLIDE

13'-15.5' CLAYEY SAND with GRAVEL:

(derived from the Rocky Flats

Alluvium); orange-brn.; wet; loose;

severely weathered Claystone (?)

SLIDE/GOUGE ? (CL)

15.5'-16' LEAN SILTY CLAY:

yellowish brn., mottled orange/

gray; v. moist-wet; appears soft

(sample disturbed by rock driven

through interval-see comments

regarding blows at right).

Possibly slide/gouge zone

(Page 104) Boring 59694

abrupt contact between silty clay
and mod. weathered claystone at
16'.

17'-17.9' Cal Mod
23/50/5";rec. 0.9/0.9
drill out to 18'

18'-20' Moss

rec. 1.8/2.0

ARAPAHOE FORMATION

16'-18' CLAYSTONE:dark gray, faint
occ. orange iron staining; mod. to
slightly weathered;friable;soft.

v. hard to advance

[Note: retained bulk
sample of fill cuttings

Soil Properties: damp;hard; (CH).

0-15' (Bucket)

18'-20' CLAYSTONE: dark gray;fresh;
friable;soft. Soil Properties:

damp;hard; (CH).

Bottom of Hole at 20'

Terminate at 20'.

Install well 2/3/95
(details on page 102)

**Boring Summary

0'-13' (?) FILL: mostly (GC);
possibly mixed Colluvium/Slide
from 11'-13'

13'-15.5' COLLUVIUM/SLIDE (SC):
derived from Rocky Flats Alluvium;
(probably slid to this position
considering sharpness of contact
with claystone at 16')

15.5'-16' BASE OF SLIDE GOUGE
possibly consisting of severely
weathered cs?)

16'-18' CLAYSTONE: mod.-slightly
weathered

18'-20' CLAYSTONE: fresh

BOREHOLE 59694 LABORATORY SAMPLES

BH00211AS, 59694, FA 3-4'

Moisture Content

9.8%

*BH00212AS, 59694 (page 315), FA 7-9'

16-23" GP, no tests

10-16" GP

Unconfined Compressive Strength Test $c = 1182$ $\phi = 0$

3-10" GP, no tests

0-3" GP

BH00213AS, 59694, FA 12-13'

Moisture Content

13.9%

*BH00214AS, 59694 (page 292), Colluvium 13-15'

7-12" CL, no test

0-7" SP/CL

Moisture and Density

15.7%

116

**BH00215AS, 59694, Fill 0-15'

Moisture Content

13.8%

Atterberg Limits

LL 47.1% PI 32

Sieve Analysis

Compaction Test

1

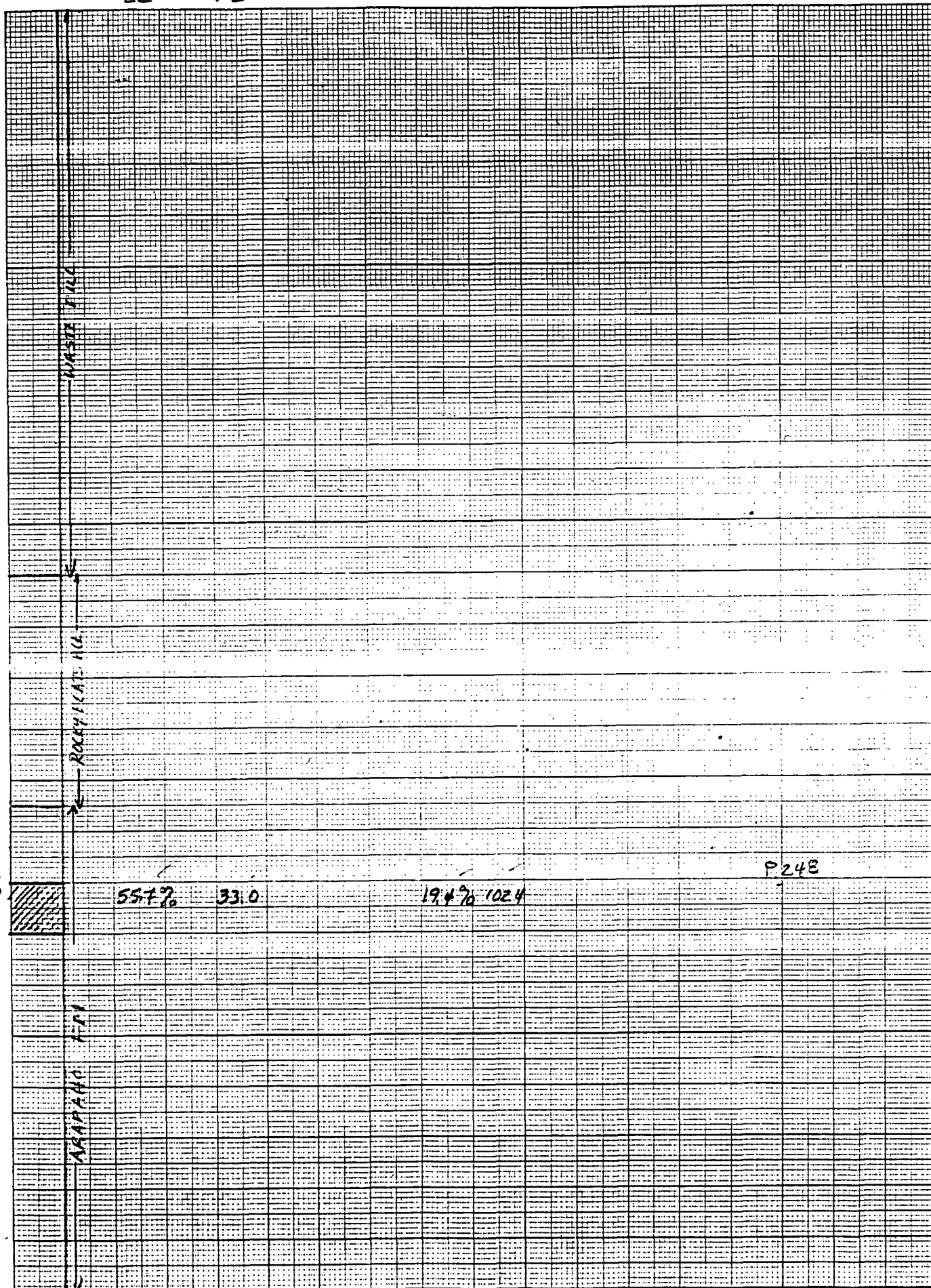
ATTERBERG
LL PI -200 SIEVE

MOISTURE TRIAXIAL DIRECT UNCON. OBSERVATIONS
DENSITY

DIETZGEN CORPORATION
MADE IN U.S.A.

NO. 341-M DIETZGEN GRAPH PAPER
MILLIMETER

17-10



TD 25.2'

Middle of fill

(Page 52) Boring 59794

Location: West portion of landfill, upper slope just east of ravine and west of trees (IHSS 196). 10' north of 58593.

Mobile B-57

Boyles Brothers

Drill with 3.25" ID Hollow Stem Augers

Moss Sampling

3" Shelby Tube (push)

Cal Mod drive sampling

water not encountered

drilled 1/9-10/95

TD @ 25.2'

Installed Piezometer (page 51)

(Page 53) 59794

WASTE FILL

0-0.2' SILTY GRAVEL (GM): mod. brn. damp; grass roots.	higher blows due to crs. gravel/cobbles? 0'-1.3' Cal Mod
0.2'-11' SANDY, CLAYEY GRAVEL (GC): dark brn.; damp-moist; f.-crs. & gravel, subangular; med. dense; locally loose-v.loose.	16/29*/38/3" bounce @ 1.3' refusal @ 1.3'; rec 0.6/1.3 drill out to 2' 2'-4' Cal Mod
mottled gray/yellowish-brn.; 30-40% mod. plastic fines; some claystone frags from 2.8-3.5'.	16/23/18/9; rec. 2.0/2.0 4'-6' Cal Mod
black SILTY SAND (fine graphite); broken glass, loose-v.loose; some voids?, from 3.5'-8.5'.	5/1/2/1; rec. 0.5/2.0 6'-8' Cal Mod
mixed gray, black, orange, (GC); med. dense; moist from 8.5' to 11' (graphite from 10-11')	1/1/1/1; rec 0.7/2.0 8'-10' Cal Mod 2/4/19/23; rec. 2.0/2.0 10'-12' Cal Mod 16/40/27/34; rec. 2.0/2.0

ROCKY FLATS ALLUVIUM

11'-15.5' SANDY, CLAYEY GRAVEL (GC): orange brown; moist; med. dense-dense; f.-crs., subangular gravel, some cobbles; mod. plastic fines.	12'-12.5' Cal Mod 70/6"; refusal @ 12.5' rec. 0.3/0.5 drill out to 13'
fine CLAYEY SAND (SC): orange; moist med. dense; from 13-14.8'.	13'-15' Cal Mod 12/18/26/26 rec. 2.0/2.0

(Page 54) Rocky Flats Alluvium (cont.)

GC, as above, from 14.8'-15.5'	15'-17' Cal Mod
[contact with RF Alluvium approx. 25°-30°, irregular; appears depositional	

ARAPAHOE FORMATION

15.5'-23.5' CLAYSTONE: gray-brn.; mod.-highly weathered; plastic-friable; soft. Soil Properties: damp; hard; high plast (ch); #'s blows mod.-stiff; 15.5-16' sample	14/12/28/48 17'-18' push Shelby hard push up to 8000#; rec. 1.0/1.0 18'-18.8' Cal Mod 37/50/3"; refusal @ 18.8'
---	--

seems harder.	rec. 0.8'/0.8'
mod.-dark gray;slightly weathered;	drill out to 19'
friable below 16.5'; occ. orange	19' 1/9:1/9
iron staining along fractures,	19'-21' Moss
bedding surfaces; occ. shows	rec.2.0/2.0;bag 20.5-21'
subhor. bedding.	dry hole @ 10:30 AM
Locally silty SILTY CLAYSTONE	21'-23' Moss
(CL): below 18'	rec. 2.0/2.0
mostly yellowish-brn., mottled	23'-23.5' Cal Mod
orange,gray;mod.weathered;friable	80:6;;refusal
from 20'-23'	rec. 0.5/0.5
iron staining along fractures;	23.5'-24.5' Moss
friable;slightly weathered from	rec. 1.0/1.0
23'-	(sample appears pulverized
Vertical fracture;iron stained	by drill action w/ Moss
@ 23'.	24.5'-25.2' Cal Mod
23.5'-25.2' SILTY CLAYSTONE: gray;	48/50/2;; refusal
fresh;friable. Soil Properties:	bag sample
damp;hard;low plastic (CL)	
Terminate at 25.2'	Installed Piezometer

(Page 55) Installation of Piezometer

2" PVC: 11-21'
.010"screen
10/40 sand 10'23' deep well
bentonite pellets: 8'-10'
sump (blank) PVC: 21'-23'
caved material: 23'-25.2'
grout (bentonite slurry): 0'-8'

BOREHOLE 59794 LABORATORY SAMPLES

*BH00178AS, 59794 (page 307), Claystone 17-18'

8-15"	CL		
	Atterberg Limits Test	LL 55.7%	PI 33.0
	Grain Size Analysis		
	Hydrometer Test		
6-8"	CL		
	(Consolidation Tests)		
0-6"	CL		
	Moisture and Density	19.4%	102.4

ATTERBERG
LL PI -200 SIEVE

MOISTURE
DENSITY

TRIAXIAL DIRECT UNCON. OBSERVATIONS

DIETZGEN CORPORATION
MADE IN U.S.A.

NO. 341-M DIETZGEN GRAPH PAPER
MILLIMETER

14-16'
Claystone

16-17.5'
Claystone

WASTE FIL

RFA

ARA RAMP

66.8% 44.7

m. 1368
± 0.0425

22.8% 99.9

16.5% 108

BOREHOLE 71194

(TO 150')

Adjusted to 5000 0-25'

The diagram illustrates a 1D lattice chain. It consists of a horizontal line with several vertical bars representing lattice sites. The sites are labeled with 'a' and 'b' in a repeating pattern. The chain is connected by horizontal lines, and there are additional vertical lines at the ends.

АРАПАНОВ К.М.

ARAPAHOE FM

ARAI'AHDE FM

LOGS OF THE FISH BOAT
NO. 100-125

NO. 100-125
FISH BOAT

ARAPAHOE RIVER

100-125'

ARAPAHOE FA

(Page 58) Boring 71194

Location: 6' south of 59794

Mobile B-57 (2 rigs: 1 auger, 1 core)

Boyles Brothers

Drill with 3.25" ID Hollow Stem Augers: 8.25" ID for casing
3" Shelby Tubes

Cal Mod drive sampling: H.X. Core w/ clear water below 26'
water not encountered-very moist to wet fill at 11.0'-11.3'

(note: HX core = 3.5" OD, = 2.5" ID)

drilled 1/11/95, 1/18-23/95

TD @ 150'

(Page 59) Boring 71194 (cont.)

WASTEFILL

0'-11.3' CLAYEY GRAVEL, SAND (SC): without sampling.
(refer to log of 59794 for v. rough drilling
detailed description of fill) cobbles? at 10'
black, v. moist-wet clayey sand (SC) 11'-12.3' Cal Mod
[fill], from 11'-11.3' 31/34/50/4"
refusal at 12.3'

ROCKY FLATS ALLUVIUM

11.3'-13.5' SANDY, CLAYEY GRAVEL
(GC): orange-brown; moist; med.
dense-dense; f.-crs. gravel, some
cobbles. drill out to 13'
13'-14' Cal Mod
24/17 (short drive)
rec. 0.5/1.0

ARAPAHOE FORMATION

13.5'-15' FAT CLAY/CLAYSTONE (CH): push up to 3000 #
yellowish-brn., mottled orange, rec. 2.0/2.0
gray; damp-moist; v. stiff; [(Cal 16'-17.2' Push Shelby
Mod sample) pp=4.5+ tsf @ 14'] but v. hard push below
blows indicate softer; high plast; 17' (up to 6000 #)
Rock Properties: severely rec. 1.2/1.2
weathered; plastic; soft.
15'-24' CLAYSTONE: gray, gray drill out to 24'
brn.; mod.-slightly weathered; 24'-26' Moss
friable; soft. Soil Properties: rec. 1.2/2.0
damp; hard; high plastic (CH).

(Page 60) Boring 71194

24'-27' SILTY CLAYSTONE (CL):
gray; fresh; friable; soft.

Soil Properties: damp; hard; low-
mod. plasticity to 27'; below 27'
predominantly claystone; generally
appears massive (core has numerous
hor. polished breaks, and is freq.
ground adjacent to breaks due to
drill action)

27'- CLAYSTONE (CH): dark gray;
fresh; friable; soft; massive. Soil
Properties: damp; hard; high plas.;
Locally SILTY CLAYSTONE (CL): occ.
brn., rounded, hard cs inclusions

set 6" ID schedule
80 PVC casing to 26';
grout in place 1/12/95
26' 1/11/95:1/18/95
26'-27' H.X. Core
Full fluid return
rec. 0.6-1.0
27'-32' H.X. Core
11:35-11:56, full return
21 mins; rec. 3.4/5.0
32'-37' H.X. Core
12:05-12:31, full return
26 mins; rec. 2.3/5.0
37'-42' H.X. Core

(possibly iron concretions) some
vert., slick surfaces (polished
w/out distinct striations.
some slick surfaces at 30°-60° pump
from 33'-35' (poor recovery of
run 32'-37') near vertical, slick
fracture surfaces from 37'-38'

full fluid return
rec. 3.5/5.0
(note: drilling reduced
(fluid) rate
after poor recovery
in previous (32'-37')
run; rec. somewhat improved)

(Page 68) cont. from page 60 71194
27'-150' claystone (cont.)
near vert., slick fracture surfs.
spotty, yellowish-brn. (iron
staining) within rock ground mass
(not along fracture surfaces)
from 37'-38' apprs crushed, soft-
consistency, some slickensides
from 43'-443.5' (possibly
mechanical, or mechanical in
part?)
hard, subrounded, brn. cs frags.
(rip up clasts?), at 60.5'
occ. black (manganese?) stained
fracture surfaces (noted) from 60'
-61' (partially open-30° fracture
coated w/ black (manganese?)
material.
mainly SILTY CLAYSTONE (CL): from
62.5'-64' (core logged to 63.7')
Total Depth 150'

42'-47' HX core;
stop @ 45' @ 1:30PM
resume at 3:10 PM
Full fluid return
rec. 2.6/5.0
47'-52' H.X. core
3:53-4:07 (14 mins)
driller signif. increased
down pressure, prod. vast
improved recovery
rec. 5.0/5.0
52' 1/18:1/19
52'-57' H.X. Core
rec. 1.7-5.0
57'-62' H.X. core
rec. 4.3/5.0
62'-66' H.X. Core
rec. 1.7'/4.0

BOREHOLE 71194 LABORATORY SAMPLES

*BH00183AS, 71194 (page 308), Claystone 14-16'

15-24" CL, no tests

13-15" CL

Grain Size Analysis

Hydrometer Tests ✓

9-13" CL

Atterberg Limits Test

LL 66.8% PI 44.7

6-9" CL

Direct Shear Test ✓

P 770

0-6" CL

Moisture and Density

22.8%

99.9%

*BH00184AS, 71194 (page 309), Claystone 16-17.5'

12-17" CL, no tests

6-12" CL, no tests

0-6" CL

Moisture and Density

16.5%

108

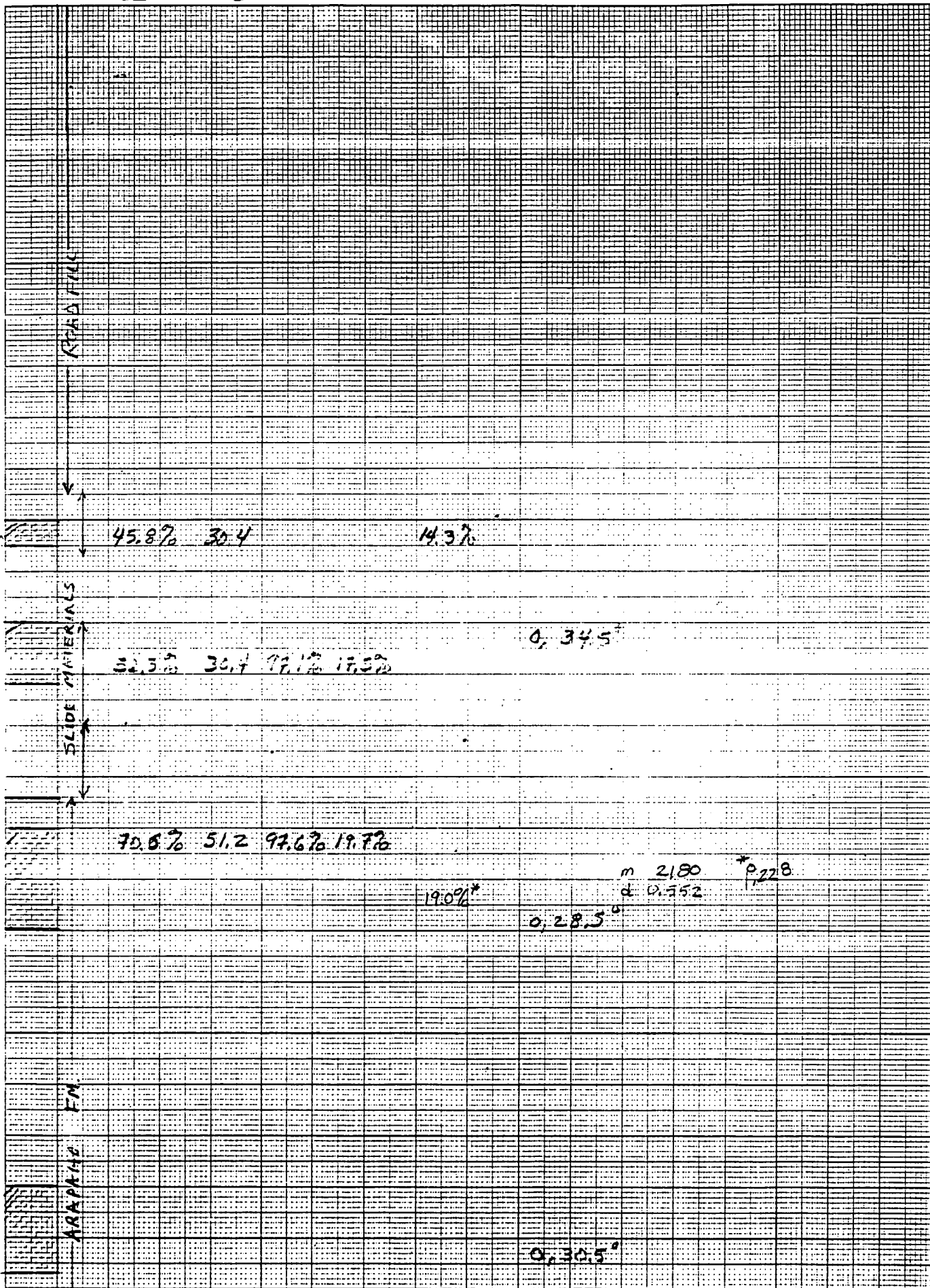
Atterberg LL PI -200 SIEVE

MOISTURE DENSITY

TRIAXIAL DIRECT UNCONF. OBSERVATIONS

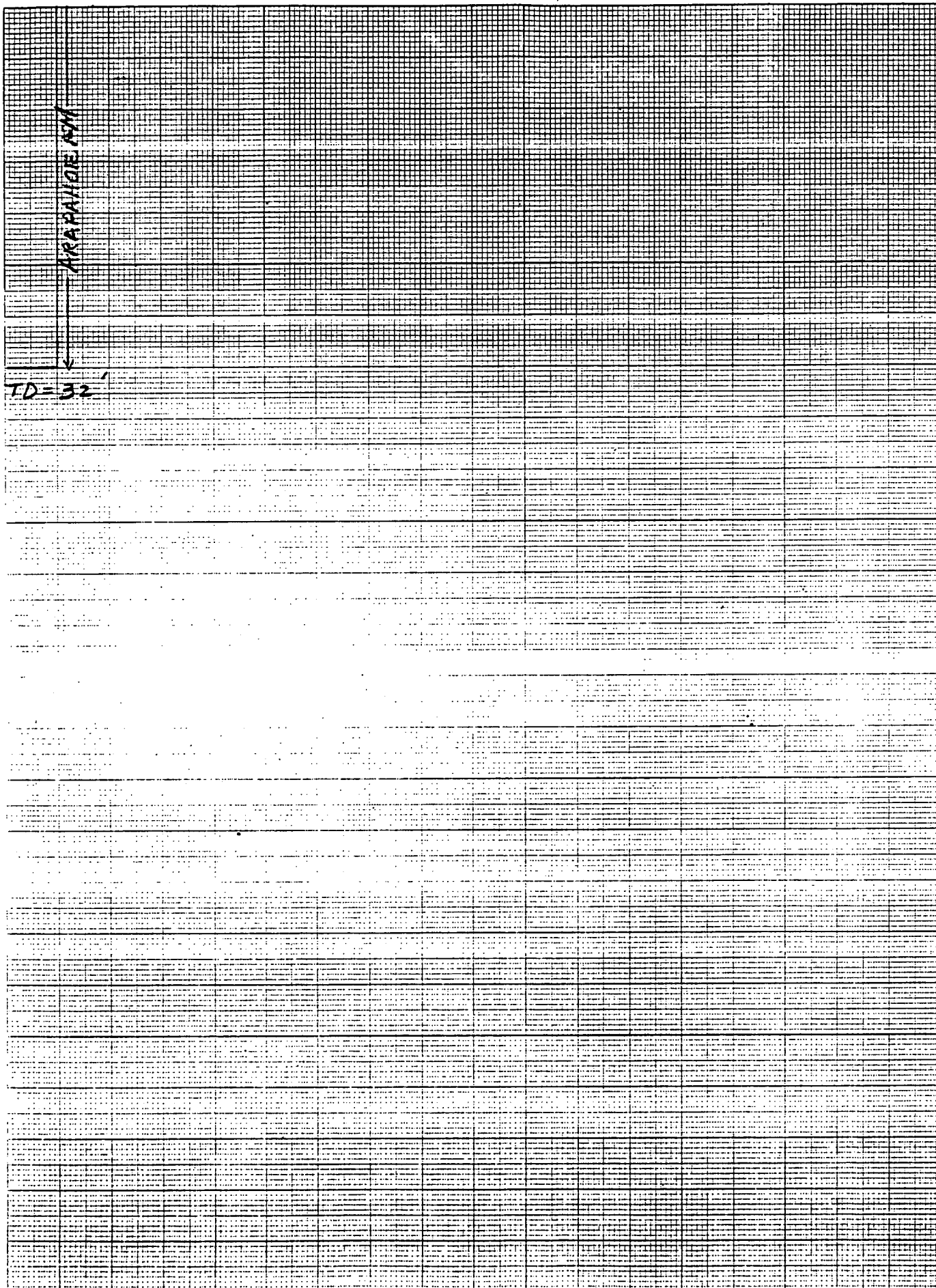
DIETZEN CORPORATION
MADE IN U.S.A.

NO. 341-M DIETZEN GRAPH PAPER
11 INCHES
16-18"



BONEHILL 59294

TOT. OF FILL
CORRECTED B-B



BOREHOLE 5929-1

(Page 39) Boring 59294

Location: South edge of road along SID, within 19.5' of slide area;
west portion of landfill just east of gull with IHSS 196 ponds.

Mobile B-57

Boyles Brothers

Drill with 3.25" ID Hollow Stem Augers

Moss Sampling

3" Shelby Tube (push)

Cal Mod drive sampling

water not encountered

drilled 12/21/94

TD @ 32'

Installed piezometer, 12/22/94

(Page 40) 59294 cont.

ROADFILL shoulder/replaced

0'-2' Moss

waste fill 0'-0.1 grass roots soil rec. 1.5/2.0

0.1-9.5' SANDY, CLAYEY GRAVEL, 2'-4' Moss

SANDY CLAY (GC,CL): mixed mod. rec. 1.5/2.0

brn., dark brn.; damp; appears dense; 4'-6' Moss

f.-crs. gravel, some cobbles; mod. rec. 1.2/2.0

plastic fines; mostly H-Mod. brown 6'-8' Moss

below 2', mostly GC below 2' rec. 1.2/2.0

8'-8' Cal Mod

COLLUVIUM/SLIDE MATERIAL

refusal at 8': no adv.

9.5'-10.7' sandy clay (CL): yellow-

brn., mottled orange, some gray;

mostly rough drilling,

moist; v. stiff; mod. plastic;

0-10', 8'-10' Moss

f.-crs. sand.

rec. 0.8-2.0'

10.7-12' GRAVELLY, SANDY CLAY TO

10'-12' Cal Mod

SANDY CLAYEY GRAVEL (CL-GC): yellow- *10/21/28/29 BH00170AS

brn., mottled; moist; v. stiff; med. rec. 2.0/2.0; (bag samp.

dense; f.-crs. gravel in clay

10'-10.5')

matrix.

12'-13.9' BH00171AS Push.

Shelby easy push to 13.5'

somewhat harder (up to

1,000#) to 13.9'

rec. 1.2/1.9' (is in tube bot.

mod. weathered) drill ou to

14', 14'-16' Cal Mod

CLAYSTONE/SLIDE MATERIAL

12'-14' CLAYSTONE: yellowish-brn.,

mottled orange/gray; mod. wthered;

friable; soft; closely fractured.

(Page 41) 59294 cont.

SILTSTONE/SLIDE MATERIAL

14'-15.4' SILTSTONE: H. brn.-yellow,

brn.; mod.-sev. weathered; friable;

soft; mixed, soft rock frags. (shows 14'-16' Cal. Mod.

some breccia structure). Soil

12/13/12/14

Properties: damp; stiff SANDY SILT rec. 2.0/2.0

(ML). Sharp smooth, flat, contact

with clay/claystone @ 15.4' (roots

penetrating from 15' in siltstone
to 15.6' in clay/cs)

ARAPAHOE FORMATION

15.4'-17' FAT CLAY (CH)/CLAYSTONE:
dark gray;moist;stiff-v.stiff.

occ. roots; some iron staining.
Rock Properties: sev. weathered;
plastic;soft.

17'-29' CLAYSTONE: mod.-highly
weathered, dark gray, some orange
iron staining along bedding; occ.
rootlets penetrating along
fractures;friable;soft.

Soil Properties: damp, hard,
FAT CLAY (CH): mod. weathered below
18'; no roots below 19';slickensides
(striations along horizontal
surfaces.) @ 21'

pp=4.0+ at 16'
blow counts indicate
softer material

BH00172AS

16'-18' Push Shelby
steady increase to

4,000 psi, rec. 1.1/2.0

18'-19' Cal. Mod.

18/ 50/6";refusal @ 19'

rec. 0.9/1.0

19'-21' Moss

rec. 2.0/2.0

(Page 42) 59294

17-19' CLAYSTONE (cont.) occ.
slickensides observed from 21'-29'
orange (heavy iron stained) from
22.5'-23'

rare iron staining/slightly
weathered from 25'-28'

appears locally crushed/pulv.*
some vertical fractures, from 25'-
29'.

29'-32' SILTY CLAYSTONE: mod.-dark
gray,;fresh;friable;soft;thinly
laminated;samples break along .25"
thick horizontal laminae. Soil
Properties:damp-dry;hard;mod.
plastic to low plastic (CL);
Terminate at 32'

21'-23' Moss

rec. 2.0/2.0

23'-24.7' Push Shelby

(ASI BH00173AS)

increase up to 6,000#

rec. 1.5/1.7, drill out-25'

25'-27' Moss

rec. 2.0/2.0

29'-29.7' Cal Mod

70/8"; refusal

*crushed texture possibly

mechanical

drill out to 30'

30'-32' Moss

rec. 2.0/2.0

Install piezometer 12/22/94:

2" PVC screen: 15'-17'

16/40 sand: 19'-10'

Bentonite Pellets: 19'-23'

caved native: 23'-32'

Bentonite Pellets: 10'-8'

Bentonite grout: 0'-8'

BOREHOLE 59294 LABORATORY SAMPLES

BH00170AS, 59294, Colluvium 10-10.5'

Moisture Content

14.3%

Atterberg Limits

LL 45.8% PI 30.4

Sieve Analysis

***BH00171AS, 59294 (page 301), 12-13.2'**

10-17" CL

Triaxial Compression Test (pore pressure) $c = 0$ $\phi = 34.5$

4-10" CL

Atterberg Limit Test

LL 52.3% PI 30.4

-200 sieve fraction

97.1% 17.5%

***BH00172AS, 59294 (page 302), 16-18'**

9-13" CL

Atterberg Limits Test

LL 70.6% PI 51.2

-200 sieve fraction

97.6% 19.7%

7-9" CL

Direct Shear Test

6-7" CL

Consolidation Test

0-6" CL

Triaxial Compression Test (pore pressure) $c = 0$ $\phi = 28.5$

***BH00173AS, 59294 (page 303), 23-24.7'**

12-19" CL, no tests

7-12" CL, no tests

0-7" CL

Triaxial Compression Test (pore pressure) $c = 0$ $\phi = 30.5$

MOISTURE DENSITY TRIAXIAL DIRECT UNCONF. OBSERVATIONS

4.-5.2

DIETZGEN CORPORATION
CHAD, ILL. U.S.A.

AND, JUDITH FOR ZEN THE BROTHER

Amplified

TD=17

Box 100 59094

TOE of slide

(Page 81) Boring 59094

Location: New Woman Creek; 30' east of well 5786.

Mobile B-57

Boyles Brothers

Advanced hole with 3.25" ID Hollow Stem Augers

3" Shelby Tubes

Moss Sampling

Cal Mod drive sampling

water measured at 12.4' after drilling

drilled 1/30/95,

TD @ 17'

(Page 82) Boring 59094 (relogged on page 90 & 91)

COLLUVIUM

0-2.3' SANDY, CLAYEY GRAVEL (GC):
orange-brn.; moist; occ. cobble
(hard drilling); includes some clay
(CL-CH); appears soft. Possibly
FILL or SLIDE.

2.3-3.3' SANDY-SILT/SILTSTONE:
yellowish-brn.; sand/silt; moist;
dense; grading to silty; more
sandstone at 3.3'; severely
weathered siltstone grading to
silty-fine sandstone.

3.3-3.6' SILTY SAND/f.grained
SANDSTONE: brnish-gray, silty sand;
moist; dense;
f. grained SILTY SANDSTONE;
severely weathered; grading to
claystone.

3.6-4.7' CLAYSTONE: severely
to mod.- weathered; claystone;
brownish-gray w/iron staining;
mottled; moist.

4.7-5.5' GRAVELLY, CLAYEY SAND -
SANDY, CLAYEY GRAVEL (SC-GC)
(COLLUVIUM?): tip of Shelby
tube contained alluvium w/ rootlets;
dark-brn.; moist;

(Page 83) Boring 59094 (cont')

ALLUVIUM

5.5-12' SANDY, CLAYEY GRAVEL (GC):
orange-brn.; moist; wet below 11';
f.-crs. gravel, cobbles.

ARAPAHOE FORMATION

12-17' CLAYSTONE (CL-CH):
yellowish-brn., mottled orange;
highly-mod. weathered; mod.
weathered below 13'; plastic
-friable; soft. Soil Properties:
hard; damp; mod.-highly plastic;
predominantly gray, occ. orange

0-2' Moss

rec. 1.9/2.0

2-4' Cal Mod

28/22/20/24

rec. 2.0/2.0

4-5.2' push Shelby

rec. 1.2/1.2

crimped end of base

5.2-6.0' Cal Mod

34/50 @ 3'

rec. 0.8/0.8

*Note: presence of
relatively undisturbed
claystone over alluvium
suggests possible slide
material, 0-4.7'
(also, possibly sloughed-in
detrital block of
claystone) not as likely
due to creek floor.

Very hard drilling
at 6' (cobble) to 7'

7.0-7.2' Cal Mod

50 for 2"

no rec.

attempted to drill
out of cobbles; advanced
hole to 8' and
stopped because hole
could not be advanced
through cobble/boulder
Moved rig back 2.5'
and started new hole.
drill to 11' without
sampling 11-13' Moss

staining below 15'.

rec. 1.0/2.0
13'-14.8' push Shelby
rec. 1.8/1.8
drill out to 15'
15'-15.8' Cal Mod
39/50/4"; refusal
15.8'; rec. 0.8/0.8
drill out to 16'
16'-17' Cal Mod
45/50/6" refused at 17'
Terminate at 17'.

(Page 90) Boring 59094 (relogged core)

COLLUVIUM/SLIDE

0'-2.3' SANDY, CLAYEY GRAVEL (GC): orange-brn.; moist; includes some pockets of greenish-gray; v. moist; CLAY (CL-CH): clay appears soft.

0'-2' Moss.

rec. 1.9-2.0
2'-4' Cal Mod
28/22/20/24

rec. 2.0/2.0

4'-5.2' Push Shelby

BEDROCK/SLIDE

2.3'-3' SANDY SILTSTONE: yellowish-brn., mottled orange; mod.-highly weathered; friable; soft. Soil Properties: damp; med.-dense.

rec. 1.2/1.2; crimped
end of tube

3-4.5' CLAYSTONE (ML): gray-brn.; mod.-highly weathered; plastic-friable; soft. Soil Properties: moist; v. stiff; (CL-CH). Includes some sandy-silt laminae.

(Note: bedrock material from 2.3'-4.5' appears mostly intact/unmixed shows some recognizable, stained fractures & rock structure): however, does appear somewhat disturbed Presence of this material over alluvium suggests possible slide, 0'-4.7'

(Page 91) relogged core (59094)

COLLUVIUM

4.5'-5.5' GRAVELY, CLAYEY SAND-SANDY, CLAYEY GRAVEL (SC-GC): dark-brn.; moist; rootlets; (possibly organic stained, surficial alluvium).

5.2'-6' Cal Mod

34/50/3"; rec. 0.8/0.8

v. hard drilling

5.6'-7' cobbles

7'-7.2' Cal Mod

50 for 2"; no rec.

attempt to drill

out below cobbles;

ALLUVIUM

5.5-12' SANDY, CLAYEY GRAVEL (GC): orange-brn.; moist; wet below 11'; f.-crs. gravel, cobbles.

advance augers to 8'

auger refusal at 8'

move hole 2.5' east

drill to 11' w/out samp.

11'-13' Moss

ARAPAHOE FORMATION

12-17' CLAYSTONE: yellowish-brn., mottled orange; highly-mod. weathered below 13'; plastic to friable; soft. Soil Properties: hard; damp; mod.-highly plastic (CL-CH); predominantly gray, occ. orange staining below 15'.

rec. 1.0/2.0

13'-14.8' push Shelby

rec. 1.8/1.8

drill out to 15'

15'-15.8' Cal Mod

39/50/4"; rec. 0.8/0.8

drill out to 16'

16'-17' Cal Mod

Hole bottom at 17'
grout backfill

45/50/6"; rec. 1.0/1.0
Terminate at 17'

BOREHOLE 59094 LABORATORY SAMPLES

*BH00202AS, 59094 (page 291), Colluvium/Claystone 4-5.2'

8-14" ML, no test

2-8" ML

Moisture Content

15.1%

Observations

6-6.7'
Waste Fill

COLLEGE OF EDUCATION

NO. 441-M CIV. PROC. 1977-1978

15-12
RFA

17-19
RFA

	WASTE FINE	AVG D-11	RFA
Non Plastic	4.1% 0.3%		
	35.4% 17.3 16.4% 8.4%	43% 25	42%
			12.4% 99.2
			13.9%
	34% 17.9 28.2% 16.5%		16.8% 90.4

Box 101-56994

M. 33 m. - 4' 4" Green Sand

Borehole 56994 (cont.)

Boring 56994
Location: Center landfill; upper slope (above upper scarp).
Mobile B-57
Boyles Brothers
Drill with 3.25" ID Hollow Stem Augers
3" Shelby Tubes
Moss Sampling
Cal Mod drive sampling
water first encountered @ 22'; measured at 16.7' on 1:17 AM.
drilled 1/16/95
TD @ 29'
Install Well 1/17/95

(Page 64) Boring 56994

WASTE FILL

0'-10' SANDY, CLAYEY GRAVEL (GL):	0'-2' Cal Mod
mod.-dark brn.; damp; med. dense;	15/17/24/33
f.-crs. sand & gravel; occ. cobb.	rec. 2.0/2.0
black; moist; from 2.3-2.5'	2-4' Cal Mod
dark brn.-black; damp-moist; from	20/13/13/18
3.3-5'	rec. 1.6/2.0
dry; H. orange-brn.-mod. brn. from	bag sample 2.6'-3.4'
3.1-3.3'	4'-6' Cal Mod
loose to med. dense; v. moist; some	18/20/24/16
orange mottling; soft clay matrix	rec. 0.6
from 6'-10' (piece of wire at 9.5')	6'-7.9' Cal Mod
	10/6/8/18/5"
10'-11' SANDY CLAY (CL): mod.	bouncing 7.9'
gray-brown, some green mottling;	rec. 0.9/1.9
v. moist; firm; f.-crs. sand; some	bag samp. 6-6.9'
gravel	attempted Cal Mod 8'
increased GRAVEL (GC-CL): from	bouncing @ 8'
10.8'-11'	drill out to 9'
	v. rough drilling to 8.9'
	9'-11' Cal Mod
	12/11/6/12; rec. 2.8/2.0
	11'-13' Cal Mod

ROCKY FLATS ALLUVIUM

11'-12.2' SANDY CLAY (CL): orange	6/7/10/16; rec. 2.0/2.0
brn.; moist; firm-stiff.	13'-15' Push Shelby
12.2'-14' CLAYEY SAND (SC): orange	push up to 3000#
brn.; moist; med. dense; fine; med.	rec. 2.0/2.0
sand (minor).	bottom of tube slightly
	dented
	0-11' retain bulk sample
	of cuttings (bucket)

(Page 65) 56994 (cont.)

14-15' SANDY CLAY (CL); yellowish	15'-17' Cal Mod
brn., mottled orange, gray; moist;	6/9/10/9; rec. 2.0/2.0
v.f. sand, some crs. sand	retained bag sample,
(description based on tube bottom	15'-16'
at 15').	17'-19' push Shelby
15'-23' CLAYEY SAND w/ GRAVEL	push up to 3000 psi
(SC): orange-brn.; v. moist; loose;	rec. 1.7/2.0

f.-crs. sand, some f. gravel; mod. plastic fines.	19'-2.0 Cal Mod
v.moist to wet (traces of free water) from 19.5'-22'	8/7/19/18 rough drilling
CLAYEY GRAVEL, some cobbles (GC):	20-21';rec. 1.0/2.0
from 20'-21';wet from 22'-24'	21'-23' Cal Mod
fine (SC) from 21.5'-23'	8/9/9/35;rec. 0.8/2.0
CLAYEY GRAVEL (GC): from 22.5-23'	23'-25' Cal Mod
23'-24' SAND, CLAYEY SAND (SC-SP):	13/7/10/24
orange-brn.;wet;loose;fine;v.heavy	wet sampler 22'
iron stain at 24'.	rec. 2.0/2.0
24'-24.5' GRAVELLY CLAY (CL):	25'-27' push Shelby
yellowish-brn.,mottled orange-	push up to 7000#
gray;v.moist;stiff;f.-crs. gravel	rec. 2.0/2.0
abrupt contact w/ cs	27'-29' Moss
	rec. 2.0/2.0

ARAPAHOE FORMATION

24.5'-29' CLAYSTONE: dark gray;	install piezometer
fresh;friable;soft;generally	1/17/95 details page 66
appears massive. Noted slickensides	
on 60° fracture surface at 24.8'	
Terminate at 29'	

(Page 66) Well installation in 56994

Screen: 14.5-24.5'

Sand:12.5'-27'

Bentonite Pellets: 9.5'-12.5'

Grout bentonite: 0-9.5'

TD @ 27'

On-site at RFP at 2:50 PM. Checked with Jeff H. regarding
tomorrow's schedule. Left site at 3:45 PM.

BOREHOLE-56994 LABORATORY SAMPLES

BH00185AS, 56994, Waste Fill 2.6-3.4'

Moisture Content

Atterberg Limits non plastic

-200 Sieve Fraction 4.1% 0.3%

BH00186AS, 56994, Waste Fill 6-6.7'

Moisture Content

Atterberg Limits LL 35.4% PI 17.3

-200 Sieve Fraction 16.4% 8.4%

***BH00187AS, 56994 (page 287), Waste Fill 13-15'**

26-28" CL, no test

19-26" CL, no test

12-19" SP, no test

6-12" SP

Moisture & Density 12.4%, 99.2

0-6" CL, no test

****BH00188AS, 56994, Waste Fill 0-11'**

Moisture Content 4.2%

Atterberg Limits LL 43% PI 25

Sieve Analysis

Compaction Test

BH00189AS, 56994, Rocky Flats Alluvium 15-16'

Moisture Content 13.9%

***BH00190AS, 56994, (page 288), Rocky Flats Alluvium 17-19'**

12-21" SP/CL, no tests

6-12" SP/CL

Atterberg Limits Test LL 34.0% PI 17.9%

-200 sieve analysis 28.2% 16.5%

0-6" SP/CL

Moisture and Density 16.9% 90.4

***BH00191AS, 56994 (page 289), Claystone 25-27'**

20-24" CL (grey clay) and SP (fingers of orange-brown sand)
no tests

13-20" CL, no tests

6-13" CL, no tests

Slickensided at bottom

1-6" CL

Moisture and Density 22.0% 100.6

Numerous Slickensided areas *

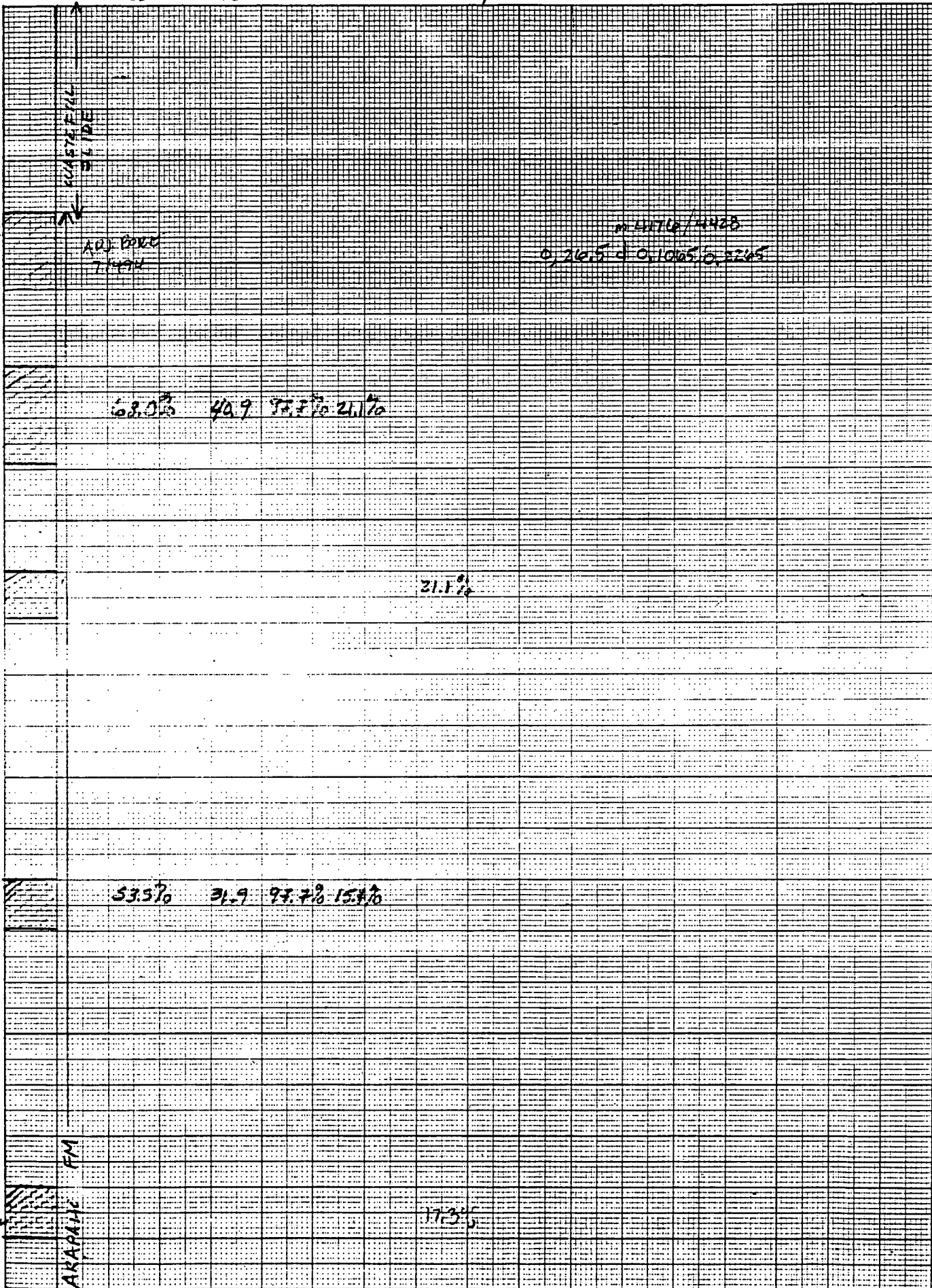
Atterberg LL PI - 200 SIEVE

Moisture Density

TRIAxIAL

DIRECT UNCON

OBSERVATIONS



THE ZIGGEN CORPORATION
1000 N. 10th St.
Grand Rapids, Mich. 49503

11-11-77
Claystone

NO. 341-M DETZLER DESIGN GROUP
1000 N. 10th St.
Grand Rapids, Mich. 49503

17-12-77
Claystone

13-24
Claystone

Boiler 57194

TD 17

TOP OF FILL 0-25'

Atterberg PI -200 SIEVE Moisture TRIAXIAL Direct UNION OBSERVATIONS
LL + Density COMP

31-32'
Claystone

ARAPAHOE FM

14.8%

12-14-52 1942

TD 150'

25-50'

AKA RANGE 1 M

UNITED STATES GEOLOGICAL SURVEY

ARAPAHOE F.M.

ARAPAHOE FM

ARAPY 1100Z FM

Boring 57194

Location: Central landfill, mid-upper slope (below upper scarp/within slide)

Mobile B-57

Boyles Brothers

Drill with 3.25" ID Hollow Stem Augers

3" Shelby Tubes

Moss Sampling

Cal Mod drive sampling

water not encountered to 32'

drilled 1/19/95, 1/27 to 2/2/95

TD @ 150'

(Page 71) 57194 (combined with page 72)

WASTEFILL/SLIDE

0'-3.2' SANDY, CLAYEY GRAVEL (GC): rec. 1.5/2.0
orange-brn, mod. brn. (mixed); dry- 2'-2' Cal Mod
moist (var.); med-dense; some cobb. bouncing @ 2'; refusal
3.2'-4' CLAYSTONE/SLIDE: gray- 2'-3' drill out with
brn., mottled orange; mod. center plug bit
weathered; friable; soft; somewhat 3'-5' Cal Mod
disturbed; some slickensides. 23/20/16/20
10⁰, planar smooth/slickensides rec. 1.8/2.0
plane, within dark brn.-black, 5'-7' Cal Mod
moist clay (CH), clay is 0.5" 19/25/32/48
thick at 4' deep (severely rec. 1.5/2.0
weathered claystone). 7'-8.9' push Shelby
push up to 8,000#
rec. 1.7/1.9; bottom 2"

ARAPAHOE FORMATION

4'-4.3' CLAY (CH)/CLAYSTONE: gray; of tube badly dented
moist; v. stiff; occ. rootlets; drill out to 9'
shows some slickensides. Rock 9'-10.4' Cal Mod
Properties: severely weathered; 20/40/50/5"; refusal 10.4'
plastic; soft; spotty caliche. rec. 1.4/1.4
4.3'-5.3' CLAYSTONE: gray brn., 10.5'-11.9' Cal Mod
mottled orange; highly weathered; 18/35/50/4"; refusal 11.9'
plastic-friable; soft; closely rec. 1.4/1.4
fractured; somewhat disturbed?; occ. drill out to 12'; bag samp.
precipitate (caliche) 11'-11.9'
5.3'-28' CLAYSTONE: gray- 12'-13' push Shelby;
v. hard push; dented bottom
rec. 0.5/1.0, no sample

(Page 73) 57194 (cont.)

5.3'-28' CLAYSTONE (cont.): gray-
brn.; mod. weathered; friable; soft;
generally mod. to closely fract.
(freq. iron stained fractures,
bedding surfaces [hor. bedding];
blocky texture.*
vertical; heavily iron-stained
frac. (joint) from 9.2'-10'
pockets (vugs), fracture coatings

see page 71 for details
of sampling and logging
to 13' deep.

3'-15' Moss; rec. 2.0/2.0
15'-17' Moss
rec. 2.0/2.0
17'-17.9' Cal Mod
32/50/5"; rec. 0.9/0.9

of white, crystalline prec.
(gypsum); from 9'-15'
Soil Properties: damp; hard; high
plastic (CH); Includes occ. iron
concretions.
SILTY CLAYSTONE (CL): from 19.5'
-22'
local interbeds/laminae of silty
claystone (CL) below 22'
somewhat decreasing fracturing
below 15' (generally, mod. fract.
*note fractures appear at random
orientations, are coated with thin
iron oxide deposits and generally
tight)

bag sample 17-17.9'
drill out to 18'
18'-20' Moss:
rec. 2.0/2.0
20'-22' Moss
rec. 2.0/2.0
22'-24' Moss
rec. 2.0/2.0
bag samp. 23'-24'
24'-26' Moss
rec. 2.0/2.0

(Page 74)

5.3'-28' Claystone desc. (cont.)
moist-v.moist, mod. heavy iron
staining from 27'-27.5'

28'-150' CLAYSTONE: dark gray;
fresh; friable; soft; generally
appears massive (fractures infreq.
noted). Soil Properties: damp;
hard; high plastic (CH); locally
silty (CL).

[Note: following log produced
after drilling (log of core in
ASI trailer)]

scattered hard, yellowish-brn.
claystone nodules, subrounded
from 34-35' (nodules appear
encased in undisturbed claystone
no apparent shearing or disturb.
locally hard, cemented (carb.),
caliche zone; includes some nods.
/clasts up to 0.5", subangular to
rounded suggesting (locally) a
breccia texture, from 38.5-39.5'

(zone includes a 1" to 2" thick, hard, cemented band showing
horizontal bedding/lamination. apparent breccia is possibly in
part or wholly due to drill action (appears natural). log continued
on page 86.

26'-28' Moss
rec. 2.0/2.0
28'-30' Moss
rec. 2.0/2.0
30'-32' Moss
rec. 2.0/2.0
bag samp. 31'-32'
32' 1/19:1/20
ream hole, set 6"
ID PVC surface casing
to 32'
1/27/95 > 2/2/95
32'-150' H.X. core
clear water drill fluid
core loss, 32'-33.5'
36.6-38.5 ASI
driller noted 30 gallons
fluid loss @ 55'
core loss, 42'-43.5' ASI

(Page 86) 57194 (cont.)

28-150' claystone (cont.)
38.5'-39.5' caliche rich zone;
possibly brecciated/disturbed
(described on page 74); *note: zone
has strong reaction to weak HCL
acid. Note: strong HCL reaction/
caliche also from 36.4-36.6
(interval immediately above zone

of core loss, from 36.6-38.5'
Therefore: zone of caliche possibly
extends from 36.4-39.5'.

yellowish-brn., hard claystone
nodule at 40.5' (within the
disturb cs)

Several hard, subang., iron stn.
nodules, up to .25" at 48.5'
cs nodules encasing clay appear
undisturbed but subhorizontal
surface could be natural shear
surface.

yellowish brn., hard cs nodules @
52' (occur at 30⁰, slickensided
surface, possible shear, where dark
brn.-gray clay occurs along olive-
gray clay-v. subtle color
difference along shear (?).

[note: driller reported
30 gallons water loss at
55'- no unusual fract. or
lithology changes noted at
that depth]

(Page 87) 57194 (cont.)

28'-150' claystone descr. (cont.) core loss from 72'-73.5'
core appears softer, shows numerous
shear surfaces at various
orientations from 73.5' to 74.5'
(possibly mech.)

black carbonaceous from 74.5' to
75.5' (lignite/coal)
logged to 84.5'
below Woman Creek elevation

Hole completed at TD @ 150'
2/2/95

BOREHOLE 57194 LABORATORY SAMPLES

*BH00192AS, 57194 (page 310), 7-8.9'

15-21" , no tests

13-15" , no tests

8-13"

Atterberg Limits Tests

LL 68.0% PI 40.9

-200 sieve analysis

97.7% 21.1%

1-8" no tests

BH00193AS, 57194, Claystone 11-11.9'

Moisture Content

21.1%

BH00194AS, 57194, Claystone 17-17.9'

Moisture Content

Atterberg Limits

LL 53.5% PI 31.9

-200 sieve Analysis

97.7% 15.4%

BH00195AS, 57194, Claystone 23-24'

Moisture Content

17.3%

BH00196AS, 57194, Claystone 31-32'

Moisture Content

14.8%

BOREHOLE 71494 LABORATORY SAMPLES

*BH00243AS, 71494 (page 319), Fill/Claystone 4-5.5'

16-20" SM, no tests

12-16" ML, no tests

9-12" ML

Direct Shear Test

6-9" ML

Direct Shear Test (replaces BH00192AS ***).

0-6" ML

Triaxial Compression Test (pore pressure) $c = 0$ $\phi = 26.5$

71494 100
well log
71494

Atterberg LL PT -200 SIEVE

Moisture Density

TRIAXIAL

Direct Shear

UNCONFINED COMP.

OBSERVATIONS

DIETZEN CORPORATION
MADE IN U.S.A.

10-10.5'
10.5-12.5
Colluvium

41.0% 26.6

16.7% 0

8.1%

18.3% 76.8

14.5-15.5
Colluvium

57.5% 35.1

18-18.5CU
18.5-20

65.3% 48.8 60.1% 14.1%

72.9% 52.1

Parcel 570-94

Adjacent to SID

Atterberg
LL PI -200 SIEVE

Moisture TRIAXIAL Direct
Density C ϕ Shear

Observations

28.5-30'

COLLUSION SLIDE

C=0 $\phi=29^\circ$
C=0 $\phi=15^\circ$
1150 15°

Combined
Triaxial
Tests
C=1150
 $\phi=15^\circ$
tan

Collusion / 3 L15
MATERIAL

TD = 40'

NO. 341-M LIEZGEN CORPORATION
MADE IN U.S.A.
LIEZGEN CORPORATION
LIEZGEN, N.J.

Borehole 57094

(Page 31) Boring 57094

Location: N. edge of road along Surface Interceptor Ditch (SID),
east portion of landfill (along section line through east slump).
Mobile B-57

Boyles Brothers

Drill with 3.25" ID Hollow Stem Auger

Moss Sampling

Cal Mod Drive Sampling

3" Shelby Tube (Push)

Water encountered at 32' perched on cs surface at 34'

Drilled 12/15-16/94

TD @ 40'

Installed piezometer, 12/17/94

Note: samples re-examined/ re-interpreted 2/2/95.

(Page 32) Boring 57094

ROADFILL (replaced waste fill) 0'-2' Moss

0'-4.5' SANDY, CLAYEY GRAVEL (GC): rec. 1.2/2.0

mixed dark brn., mod. brn., 2'-4' Moss

yellowish-brn.; damp; moist (var.); rec. 1.7/2.0

appears med. dns., f.-crs. gravel; 4'-6' Moss

rec. 1.7/2.0

v. easily drilled

from 5'-6' retain bag

sample from 5'-5.5'

6'-8.4' Push Shelby

easy push to 7.5'

FILL 4.5'-7.5' CLAYEY SAND (SC): dark

brn.; v. moist- wet; *loose; f.-crs.; grad. harder to 8.4

30-40% mod. plastic fines.

rec. 1.6-2.4

7.5'-8.5' SANDY CLAY (SC): dark

*moisture from SID

brn.-black; v. moist; stiff-v. stiff; pp=3.0 tsf @ tube bot.

SANDY CLAY (CL): 7.6' tube bottom?

8.5-10.5' Cal Mod

8.5-10.5' probably FILL; (appears
mixed); re-examined 2/2/95

5/10/10/12

rec. 2.0/2.0

8.5-10.5' SANDY, CLAYEY GRAVEL-

pp=2.5 tsf* @ 10.5'

GRAVELLY, SANDY CLAY (GC-CL):

bag samp., 10'-10.5'

yellowish-brn., mod. brn., mottled

*Note: clay matrix appears

orange, some gray; moist-v. moist;

softer above 10.2'

stiff; subrounded to ang. gravel;

(*appears mixed or disturbed)

mod. plastic fines; some striat.

/slickensides * (possibly mech.-

10.5 12/15 / 12/16

gravels smearing clay while drive

hole dry at 9:00 AM

sampling);

appears consistently SANDY CLAY

(CL): f.-med. sand from 10.2'-10.5'

30-40% mod. plastic fines.

(Page 33) 57094 cont.

yellowish-brn., v. moist, CLAYEY

10.5'-12.5' push Shelby

GRAVEL (GC): @ 11.3' (tube bottom);

softer, easier push from

clay matrix appears soft @ 11.3'

11'-11.5'; max. down press.

10.5-22' CLAYEY GRAVEL (GC), orange @ 6,000#

brn., predom. yellowish-brn.,
v. moist; med. dense; (?soft to firm
clay matrix) CLAYEY GRAVEL, f.-crs
gravel from 10.5' to 17.5'
*(includes mottled/mixed greenish
gray clay). Appears mixed with
subrounded-ang. gravels. Possibly
slide RFP alluvium material?
CLAYEY GRAVEL to GRAVELLY CLAY
(GC-CL): stiff-v.stiff from 17.5'
to 18.5'
18.5'-20' SANDY CLAY: mod. brown-
yellowish brn.; moist-v. moist;
stiff; f.-crs. sand, some f. gravel
20-22' SANDY, CLAYEY GRAVEL (GC):
yellowish-brn.; moist-v. moist;
med. dense; f.-crs. gravel; f.-crs.
sand; 20-40% mod. plastic fines;
(generally as above 18.5')
22'-26' SANDY CLAY *(CL): mod.
yellowish-brn.; moist-v. moist; v.
stiff; f.-crs. sand, some f.
gravel. [COLLUVIUM SLIDE ?]

(Page 34) 57094 cont.

Note: Colluvium slide material,
22'-34' includes varying amount of
claystone detritus?/fragments
stiff(?) from 24' to 26'
26'-32' LEAN CLAY with SAND (CL):
yellowish brn., mottled orange,
gray; moist-v. moist; stiff-v. stiff;
scattered frags.; subrounded gravel
CLAYSTONE, highly to severely
weathered, shows very faint rock
structure; from 26'-26.5'
32-34' CLAYEY GRAVEL (GC): yellowish
brn.; wet; dense; f.-crs. gravel;
subang.-subrounded gravel; mod.-
plastic fines. Appears mixed/
chaotic. Base of a possible slide?

ARAPAHOE FORMATION

34'-39' CLAYSTONE: yellowish-brn.,
mottled orange, gray; mod. weathered
friable; soft; var. shows subhor.
laminations (thin-v. thin); some
iron stained bedding, fracture
surfaces (v. narrow tight
apertures). Soil Properties:
damp; hard; mod. plastic (CL).

rec. 0.8/2.0, bad crimp tube
12.5'-14.5' Cal. Mod.
14/11/15/18, rec. 1.8/2.0
14.5'-16.5' Cal. Mod.
with Brass Liners
6/10/15/14
rec. 1.3/2.0
retain brass liners (6")
14.5'-15'
16.5'-18.5' Cal. Mod.
9/17/22/18 retain bag sam.
18.-18.5', pp=2.25 @ 18'
18.5-20' Push Shelby
steady push to 20' (v. hard
at 20') rec. 1.3/1.5 dented
bottom 6" of tube
pp. 1.75 @ 19.8 tube bottom
20'-22' Cal. Mod
9/17/21/20, rec. 2.0/2.0
22'-24' Cal. Mod.
11/20/38/44
pp=2.75 @ 23'
rec. 1.8/2.0

24'-26' Cal. Mod.
6/17/19/22 *
rec. 1.5/2.0
(sample disturbed by driving
rock [gravel/cobble] through
CL-clay appears stiff
26'-28' Cal. Mod.
10/16/23/32
rec. 2.0/2.0, pp=2.0 @ 28'
v. slight dent @ tube bottom
28'-30.5' Push Shelby
rec. 2.0/2.5
pp=1.75 tsf @ 30'
30.5'-32.3' Cal. Mod.
8/13/22/50/4"
rec. 1.8'/1.8'

wet sampler, sample @ 32'
drill to 32.5'
32.5'-34' Moss
rec. 1.2/1.5
34'-36' Moss (bag samp.
34-34.5') rec. 2.0/2.0
pp=4.5+ tsf
36'-38' Moss
rec. 2.0/2.0

39'-40' CLAYSTONE: dark gray; frsh 38'-40' Moss
slightly weathered; friable; soft. rec. 2.0/2.0, pp=4.5+
TD @ 40' Terminate at 40'

Well was installed in 57094 on Saturday, 12/17/94. Well
construction details:

Caved material: 37.5'-40'

Bentonite Pellets: 36'-37.5'

#16/40 sand: 22'-36'

Bentonite Pellets: 20'-22'

Grout slurry: 0'-20'

2" Blank PVC (sump): 34'-36'

2" .010" slotted PVC: 24'-34'

2" PVC blank: 0'-24'

BOREHOLE 57094 LABORATORY SAMPLES

***BH00138AS, 57094 (page 297), 6-8.4'**

19-21" CL, no test

9-19" CL

Atterberg Limits Test LL 41.0% PI 26.6%

Grain Size Analysis Test

Hydrometer Test

3-9" CL

Unconfined Compressive Strength Test $c = 1690$ $\phi = 0$

0-3" CL

Consolidation Test

BH00140AS, 57094, Colluvium 10-10.5'

Moisture Content

8.1%

Visual Classification

***BH00141AS, 57094 (page 286), Colluvium 10.5-12.5'**

8-12" no sample (wax and voids)

6-8" no test

3-6" Moisture & Density

18.8%

96.8

***BH00142AS, 57094 (page 298), Colluvium 14.5-15.5'**

0-6" GP, no tests

*****Page 364 ???

Moisture Content

Unit Weight

Atterberg Limits

LL 57.5% PI 35.1

Sieve Analysis

Visual Classification

Log of Tube Sample

BH00143AS, 57094, Colluvium 18-18.5'

Moisture Content

Atterberg Limits

LL 65.8%

PI 48.8

-200 Sieve Fraction

60.1%

14.1%

***BH00144AS, 57094 (page 299), 18.5-20'**

6-13" CL

Atterberg Limit Test LL 72.9% PI 52.1

5-6" CL

Consolidation Test

0-5" no sample

***BH00145AS, 57094 (page 300), 28.5-30'**

11-25" CL, no test

6-11" CL

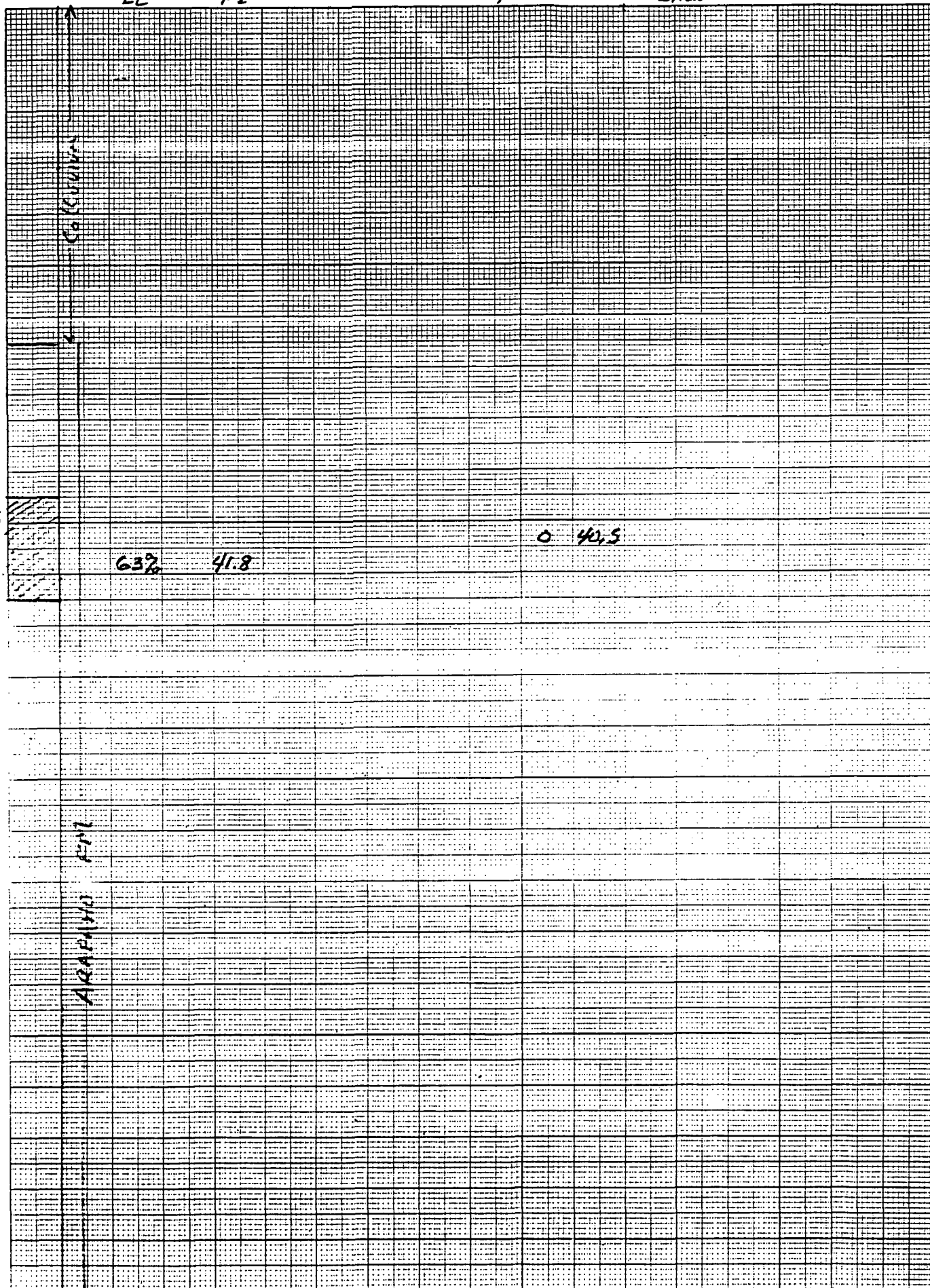
Triaxial Compression Test (pore pressure) $c = 0$ $\phi = 29.0$

0-6" CL

Triaxial Compression Test (pore pressure) $c = 0$ $\phi = 31.5$

$c = 1150$ $\phi = 15$

Atterberg PI - 200 SIEVE Moisture Density TRIAXIAL Direct Shear OBSERVATIONS
LL



BORTHOLT 56894

(100-30')

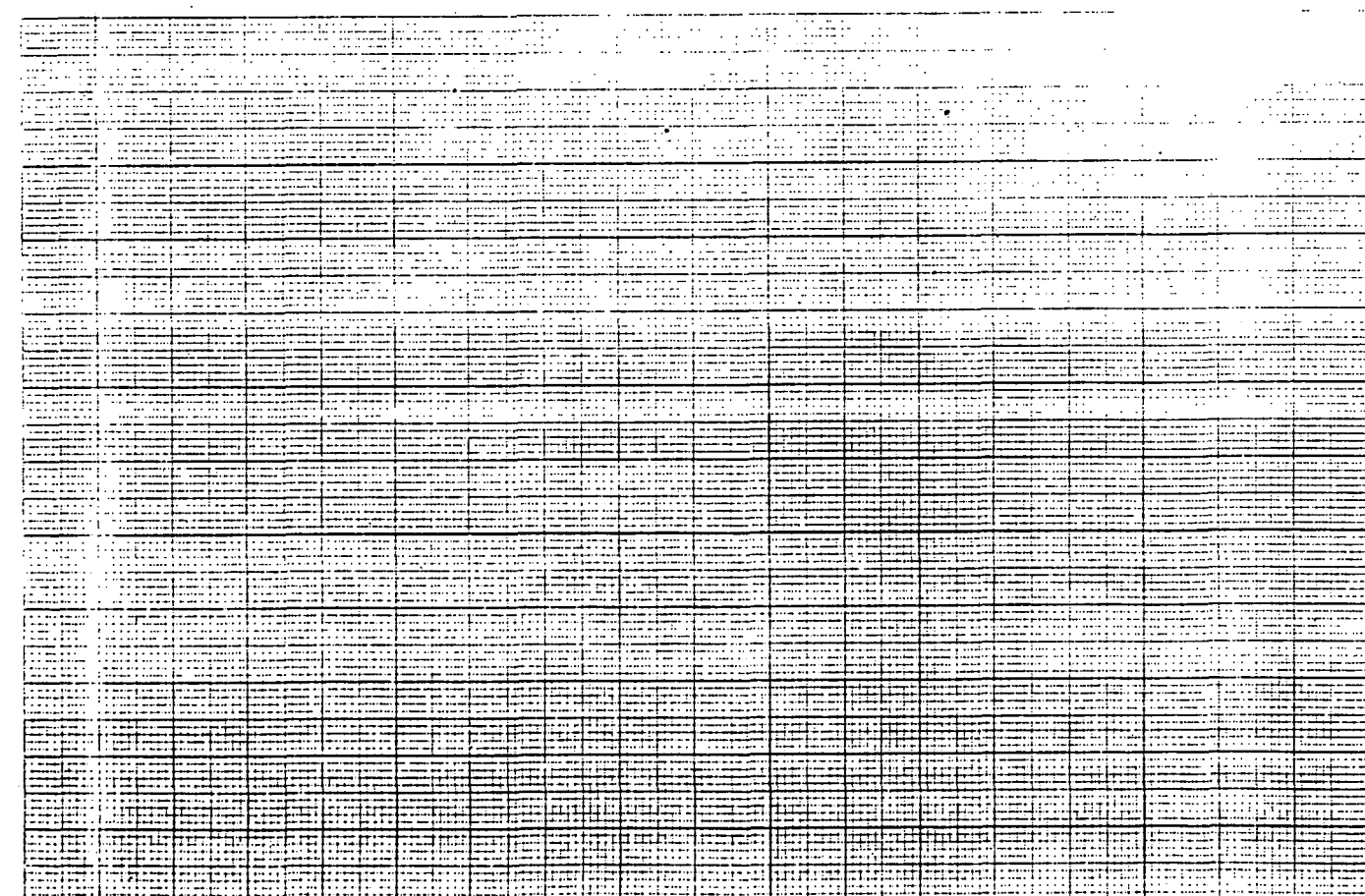
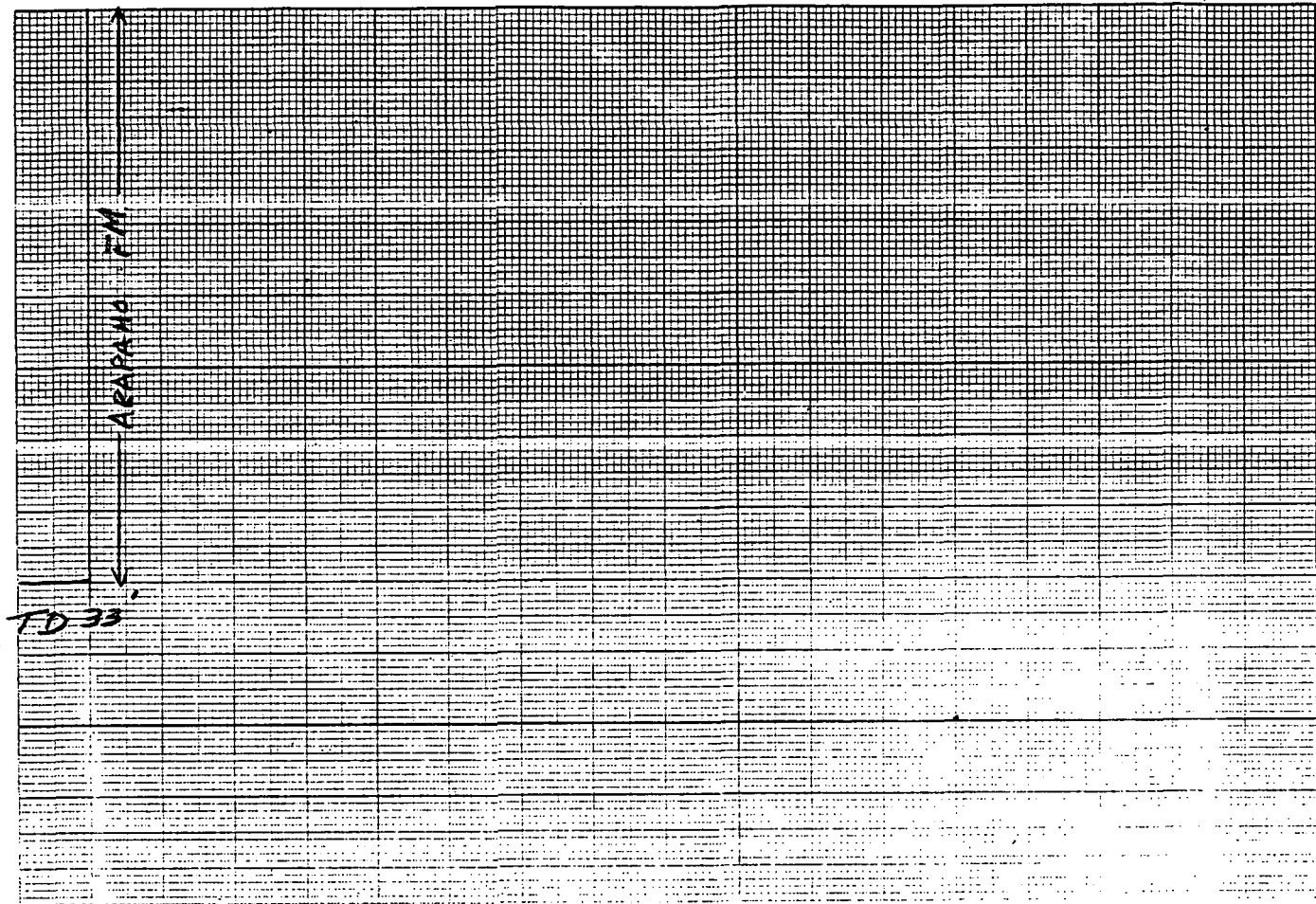
TOP of the slide
SAND

THE TETRA TECH CORPORATION
MADE IN U.S.A.

NO. TETRA TECH CORPORATION
TETRA TECH

EUGENE DIETZGEN CO.
MADE IN U. S. A.

NO. 341-M DIETZGEN GRAPH PAPER
MILLIMETER



BOREHOLE 56894

(Page 106) Boring 56894

Location: 60' SW of borehole 50892; approximately mid-slope above
SID, toward east end of landfill.

Mobile B-57

Boyles Brothers

Advanced hole with 3.25" ID Hollow Stem Augers

3" Shelby Tubes

Moss Sampling

Cal Mod drive sampling

water not encountered

drilled 2/6/95

TD at 33'

(Page 107) Boring 56894

COLLUVIUM (possibly FILL)

0'-0.7' GRAVELLY, SANDY CLAY (CL):	0'-2' Moss
dark brn.; damp; roots.	rec. 2.0/2.0
0.7'-6.3' SANDY, CLAYEY GRAVEL	2'-3.4' Cal Mod
(GC): yellowish-brn., mottled	27/37/50/5"
orange; damp; dense; f.-crs. gravel,	rec. 1.4/1.4
occ. cobbles.	drill out to 3.5'
6.3'-6.5' SANDY CLAY (CL): orange-	3.5'-5' Cal Mod
brn.; moist; f.-crs. sand; some	40/46/50/6"; bag samp.
gravel.	3.5-4.6'; rec. 1.1/1.5
	5-5.4' Cal Mod
	50/5" rec. 0/0.4
	drill out to 5.5'

ARAPAHOE FORMATION

6.5'-7.7' SILTSTONE/SANDY CLAYEY	5.5'-7.5' Moss
SILT (ML): yellowish-brn., mottled	rec. 1.0/2.0
orange; damp; stiff-v. stiff(?);	7.5'-9.5' Cal Mod
v. fine sand. Rock Properties:	10/19/25/33
severely weathered; plastic; soft.	rec. 2.0/2.0
7.7'-10.5' CLAYSTONE/FAT CLAY (CH):	bag samp. 8.5'-9'
dark gray-brn.; moist; stiff-v. stiff	pp=1.8 tsf @ 8.5
Rock Properties: severely	9.5'-11.5' push Shelby
weathered; plastic; soft. Includes	push to 4000# to 10.5'
some carbonaceous material.	v. hard push, up to 8500#
	from 10.5-11.5'
	rec. 1.8/2.0

(Page 108) 56894 (cont')

10.5-30.6' Claystone:	11.5'-13' Cal Mod
yellowish-brn, mottled orange,	31/38/50/6"; rec. 1.5/1.5
gray; mod. weathered; plastic to	13'-15' Moss
friable; soft; occ. iron	rec. 2.0/2.0
concretions; numerous v. fine	bag sample 14'-15'
silty sand-sandy silt (gray)	15'-17' Moss
laminae/pockets**. Soil	rec. 2.0/2.0
Properties: damp; hard; mod.-high	17'-19' Moss
plastic (CL-CH). Generally thinly	rec. 2.0/2.0
laminated; mod. fractured (numerous	19'-21' Moss
tight, iron stained bedding	rec. 2.0/2.0
surfaces, fractures). Includes	bag sample 20-21'
some carbonaceous material.	21'-23' Moss
damp to moist, locally moist	rec. 2.0/2.0

below 21'

(Page 109) Boring 56894 (cont.)
10.5'-30.6' Claystone (cont')
moist from 30.5'-33' Claystone:
dark gray; fresh; friable; soft;
thinly laminated (horizontal);
w/ v. thin interbeds (up to 1/16")
of v. fine silty sand-sandy silt.
Soil Properties: damp (silty sand
laminae are dry); hard; mod.-highly
plastic; (CL-CH).

TD at 33'
Grout Backfill

23'-25' Moss
rec. 2.0/2.0
25'-27' Moss
rec. 2.0/2.0
27'-27.7' Push Shelby
push required 8500#
rec. 0.7/0.7 badly
dented bottom 3"
27.7-29' Moss
rec. 1.3/1.3

29'-31' Moss
rec. 2.0/2.0
31'-33' Moss
rec. 2.0/2.0
bag samp. 32'-33'

Terminate at 33'

BOREHOLE 56894 LABORATORY SAMPLES

*BH00218AS, 56894 (page 316), 9.5-11.5'

14-21" ML

Triaxial Compression Test (pore pressure) $c = 0$ $\phi = 40.5$

7-14" ML

Atterberg Limits test LL 63% PI 41.8

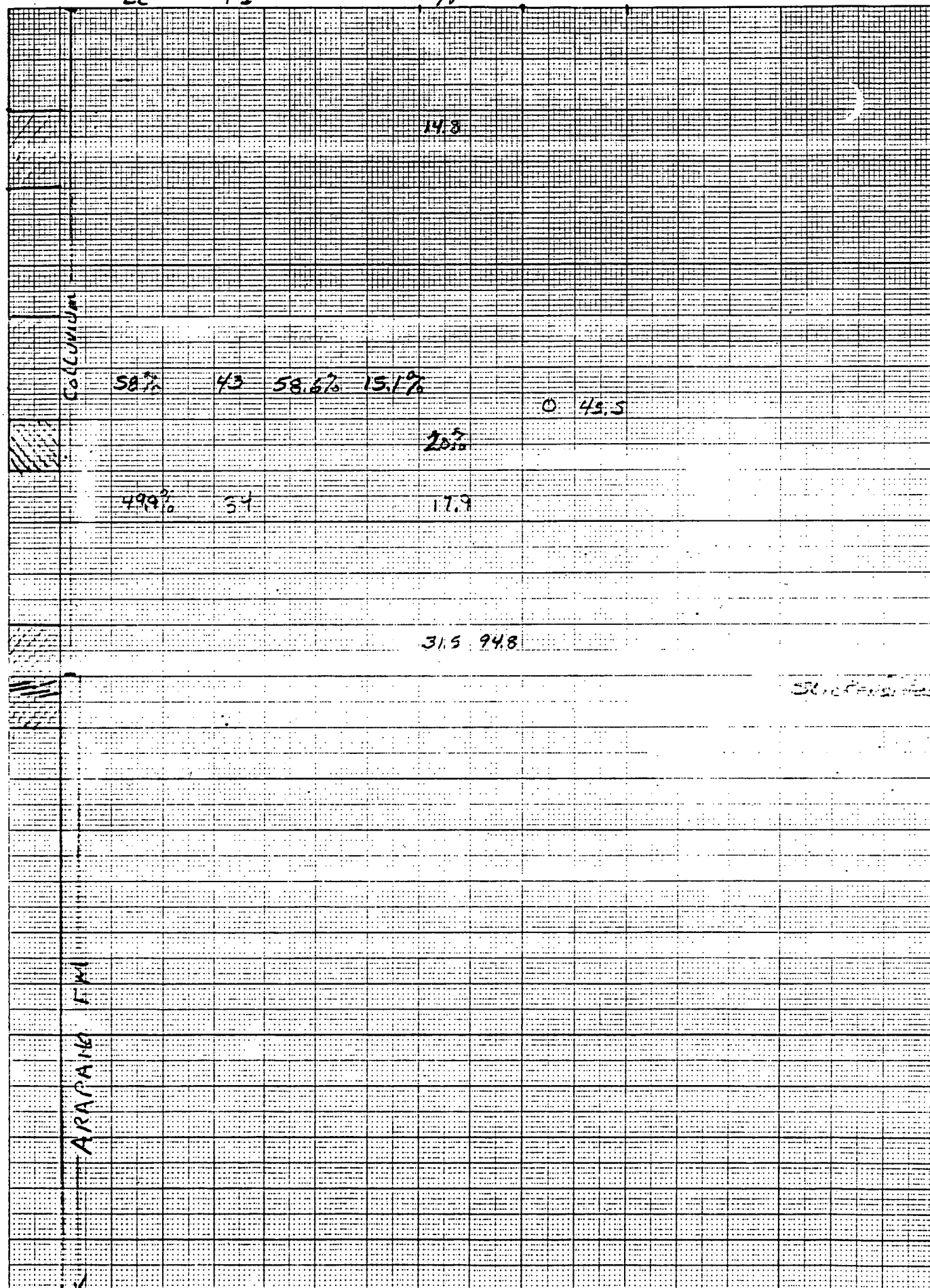
0-7" ML, no tests

Atterberg
LL PI

-200 sieve

DENSITY TRIAXIAL Direct
%

OBSERVATIONS



DIETZGEN CORPORATION
MADE IN U.S.A.

NO. 111-M DIETZGEN GRAPH PLOT
MILLIMETER

TD 25'

100

(Page 113) Boring 56794

Location: about mid-slope above SID, at east end of landfill, approx. 10' west of well.58494.

Mobile B-57

Boyles Brothers

Advanced hole with 3.25" ID Hollow Stem Augers

3" Shelby Tubes

Moss Sampling

Cal Mod drive sampling

water not encountered (v.moist to wet from 11'-13')

drilled 2/7/95

TD at 25'

(Page 114) Boring 56794 (cont.)

COLLUVIUM - possible FILL

0'-2' SANDY, CLAYEY GRAVEL (GC):
mod.-brn., orange-brn.;moist;med.
dense;f.-crs. gravel;some cobbles.

COLLUVIUM

2'-11' SANDY CLAY (CL): dark-brn.;
moist;v.stiff;minor f. gravel;occ.
roots;gray brn.;some orange
mottling below 4'.

stiff below 5'

heavy orange mottling (iron
stained) below 8'.

11'-13' SANDY, CLAYEY GRAVEL (GC):
mottled gray, orange; v.moist-wet;
med. dense;f.-crs. gravel; approx
1" thick-greenish gray clay layer
appears firm;(CL-CH): at 11.8'.

ARAPAHOE FORMATION

13'-14.5' CLAYSTONE/FAT CLAY

0'-2' Moss

rec. 1.1/2.0

2'-4' Cal Mod

23/22/33/29

bag samp. 2'-3.5'

rec. 1.5-2.0

4'-6' Cal Mod

13/19/15/16

rec. 2.0/2.0

6'-8' push Shelby

push up to 6000#

rec.1.4/2.0

pp=2.5-3.25 tsf @ 7.4'

8'-10' Cal Mod

10/12/17/15

rec. 2.0/2.0

bag samp. 9'-10'

10'-12' Cal Mod

7/10/14/14

rec. 2.0/2.0

12'-14' push Shelby

push up to 4000#

note: harder push @ 13'

rec. 1.9-2.0

pp=1.5 tsf @ 13.9'

(Page 115) Boring 56794

13'-14.5' CLAYSTONE/FAT CLAY

CLAY (ch): gray brn.;very moist;
stiff. Rock Properties: severely
weathered;plastic; soft. Includes
some black carbonaceous material.
v.stiff;mottled orange;from
approx. 14-14.5'

14.5'-15.5' CLAYSTONE: gray-brn.,
var. orange mottling;highly
weathered;plastic;soft. Soil
Properties: moist-v.moist;v.stiff
to hard;highly plastic (CH).

15.5'-22' CLAYSTONE: gray, some

14'-16' Cal Mod

15/28/35/50

rec. 1.1/2.0

16'-16.8' Cal Mod

35/50/4"

rec. 0.8/0.8

drill out to 17'

17'-19' Moss

orange Fe-staining, usually along fractures;mod. weathered;friable; soft;mod.-closely fractured;occ. shows horizontal bedding surfaces; (iron stained,tight). Soil Properties: damp;hard;CH gray-brn., yellowish-brn., mottled orange from 17'-21'; gray, some orange mottling from 21'-22'

rec. 2.0/2.0

19'-21' Moss

rec. 2.0/2.0

bag samp. 20'-21'

21'-23' Moss

rec. 1.4/2.0

(Page 116) 56794 cont.

22'-25' CLAYSTONE: dark gray; fresh;friable;soft;occ. v.thin laminae of silt;h.gray

23'-25' Moss

rec. 1.3/2.0

TD @ 25'
Grout Backfill

Terminate @ 25'

Log of *Shelby Tube, **Bulk or Bucket, and 1 gal Bag Samples
by BOREHOLE (Shelby Tube interval described from top to bottom of
tube as received from the field)

BOREHOLE 56794 LABORATORY SAMPLES

BH00228AS, 56794, Colluvium 2-3.5'

Moisture Content 14.8%

*BH00229AS, 56794 (page 317), Colluvium 6-8'

12-17" CL, no tests

6-12" CL

Atterberg Limits Test LL 58% PI 43

-200 sieve analysis 58.6% 15.1%

0-6" CL

Triaxial Compression Test (pore pressure)

$c = 0$ $\phi = 45.5$

BH00230AS, 56794, Colluvium 9-10'

Moisture Content 20%

*BH00231AS, 56794 (page 318), Colluvium/Claystone 12-14"

14-23" SW, no tests

9-14" CL, no tests

6-9" CL

Direct Shear Test

Slickensides @ 8" *

0-6" CL

Moisture and Density 31.5% 94.8

**BH00232AS, 56794, Claystone 9-10'

Moisture Content 17.9%

Atterberg Limits LL 49.9% PI 34

Sieve Analysis

Compaction Test

Atterberg PI - 200 SIEVE
LL

MOISTURE TRIAXIAL DIRECT ONCON OBSERVATION
DENSITY

2-4'
Colluvium
Claystone

vertical
crack

15.1%

6-8'

8-10'

ARAPAHO / SLIDE

0, 40.5

Combined
triaxial
shear tests
C = 350 psf
 $\phi = 18^\circ$
for
ARAPAHO /
SLIDE
MATERIALS

65.6% 43.8 99.5% 23.6%

0, 32°

12-14'

0, 27.5°

ARAPAHO (M)

BOREHOLE 57694

(TD 36.5')

MOISTURE DENSITY

DIETZEN CORPORATION
MADE IN U.S.A.

NO. 411-M DIETZEN GRAPH PAPER
COLLMETER

100

ARAPAHO

TD = 36.5'

BORE HOLE 57694

(Page 77) Boring 57694

Location: 30' west of well 59893 (within limits of apparent slide on 1951, 1937 air photo's).

Mobile B-57

Boyles Brothers

Advanced hole with 3.25" ID Hollow Stem Augers

3" Shelby Tubes

Moss Sampling

Cal Mod drive sampling

water not encountered

drilled 1/24/95, 1/27/95

TD @ 36.5'

(Page 78) Boring 57694

COLLUVIUM/SLIDE

0'-3' SANDY CLAY with GRAVEL

(CL-CH): dark yellowish-brn.;

moist; appears stiff-v. stiff;

[broken, crumbled texture below

1' (from 1' to 2') probably mech.]

3' CLAYSTONE: interface sampled in

Shelby tube. Tip: Mod. weathered

claystone; dry; some roots (from

Paul Jordan Log)

Mod. weathered, brnish-gray, dry

claystone; dry roots.

Tip: Mod. weathered claystone; dry;

iron stained (from P. Jordan log)

Cal Mod Sample Description: dark

gray claystone w/ notable vertical

fractures and iron staining;

dry to moist.

0'-2' Moss

rec. 2.0/2.0

rig down @ 2:25 PM

resume drilling at 10:30

1/27/95

Mark Yaskanin arrived at

drill site at 11:30. Hole

had been advanced to 14'.

2'-4' Push Shelby

rec. 1.9-2.0

4'-6' Cal Mod

11/15/18/19

rec. 1.3/2.0

6-8' push Shelby

rec. 2.0/2.0

8'-10' push Shelby

rec. 2.0/2.0

10-11.5' Cal Mod

16/31/48; rec. 1.5/1.5

11.5-12 drill out

12-14' push Shelby

(Page 79) Mark Yaskanin Log

14-14.5' severely weathered

claystone; yellowish-brn.; moist

(grading to moist and softer gray)

Claystone at 15' with organics

grading to mod. weathered gray

claystone with organics and iron

staining.

Continued mod. weathered dry

claystone with iron staining; v.

dense; occ. iron concretions; org.

at 18.1'.

Mod. weathered gray claystone

with iron staining. iron staining

varies with depth showing var.

gray to brownish gray samples.

Driller noted hard drilling.

14'-16' Cal Mod

9/16/21/42

rec. 2.0/2.0

bag samp. 15'

16-17.3' Cal Mod

17/44/50 for 0.3

Drill out to 17.5'

17.5-18.3' Cal Mod

50/50 for 0.3

18.3-18.5 Drill out

18.5-20.5' Moss

20.5-22.5' Moss

22.5'-24.5' Moss

24.5'-26.5' Moss

26.5'-28.5' Moss

28.5'-30.5' Moss

30.5'-32.5' Moss

Samples dry to moist (typ. moist) 32.5'-34.5' Moss
34.5'-36.5' Moss
32.5' fresh claystone: dark gray, Rec. 2.0/2.0
no more iron staining, dry to moist.
TD @ 36.5'

(Page 88) Boring 57694 relogged page 78 see above for sampling

COLLUVIUM/SLIDE

0'-2' Moss;rec. 2.0/2.0
0'-3' SANDY CLAY with GRAVEL (GC): 2' 1/24:1/27
dark yellowish-brn.;moist;stiff 2'-4' push Shelby
-v.stiff. rec. 1.9/2.0

ARAPAHOE/SLIDE(?)

3'-14.5' CLAYSTONE: yellowish-brn.,rec. 1.3/2.0
gray, mottled orange;severely to 6'-8' push Shelby
mod. weathered;plastic-friable; rec. 2.0/2.0
soft;variably fractured. rootlets 8'-10' push Shelby
to 5'. Soil Properties: damp; rec. 2.0/2.0
v.stiff-hard;mod.-highly plastic 10'-11.5' Cal Mod
(CL-CH). 16/31/48;rec. 1.5/1.5
mod. weathered w/ near vertical, drill out to 12'
heavily iron stained fracture 12'-14' push Shelby
(shows slickensides) from 10'-11.5' rec. 2.0/2.0
CLAYSTONE: yellowish-brn., 14'-16' Cal Mod
mottled orange, has crushed 9/16/21/42;rec. 2.0/2.0
appearance, w/ angular claystone bag samp. 15.1'-15.5'
fragments (fragment surfaces pp on material
showing slickensides) from 14' at 15.5' (bag)
-14.5' =1.5 tsf

ARAPAHOE FORMATION

14.5'-15.5' CLAYSTONE/CLAY (CH):

(Page 89) 57694 (cont.)

14.5'-15.5' CLAYSTONE/CLAY (CH):
dark brown-gray;v.moist;stiff;
high plastic. Rock Properties:
severely weathered;plastic;soft*.
.25' wide zone of slickensides,
iron stained, (hor. up to 20°)
at 14.5' (immediately below
contact w/ crushed looking
claystone above) 32.3' CLAYSTONE:
gray-brn.;mod.weathered;plastic
-friable;soft;mostly massive,
blocky texture*. Soil Properties:
damp;hard;mod.-highly plastic
(CL-CH). occ. black, carb.
material.

yellowish-brn.,gray,mottled
orange below 16'.

32.3'-36.5' CLAYSTONE: dark gray
-brn.;fresh;friable;soft. Soil

*includes some black
carbonaceous material.

also, occ. v.narrow
iron stained frags., some
vertical.
*locally laminated (v.thin
bedded, w/sub-horizontal,
iron stained surfaces)
16'-17.3' Cal Mod
17/44/50/4";refusal
drill out to 17.5'
17.5'-18.3' Cal Mod
50/50/4" refusal

Properties: damp;hard;mod.-highly
plastic (CL-CH).

drill out to 18.5'

18.5'-20.5' Moss

20.5'-36.5' Continuous Moss
(2' advances)

rec. 2.0/2.0, all samples

except 34-34.5' no rec./ASI

BOREHOLE 57694 LABORATORY SAMPLES

*BH00197AS, 57694 (page 290), Colluvium/Claystone 2-4'

14-22" SM

no tests

7-14" SM/ML, no tests

vertical crack down center *

0-7" SM/ML

Moisture Content 15.1%

*BH00198AS, 57694 (page 311), 6-8'

12-24" CL, no tests

6-12" CL, no tests

0-6" CL

Triaxial Compression Test (pore pressure) $c = 0$ $\phi = 40.5$

*BH00199AS, 57694 (page 312), 8-10'

6-12" CL

Atterberg Limits Test LL 65.6% PI 43.8

-200 sieve fraction 99.9% 23.6%

0-6" CL

Triaxial Compression Test (pore pressure) $c = 0$ $\phi = 32$

*BH00200AS, 57694 (page 313), 12-14'

12-25" CL, no tests

6-12" CL, no tests

0-6" CL

Triaxial Compression Test (pore pressure) $c = 0$ $\phi = 27.5$

ATTERBERG
LL DL -200 SIEVE

MOISTURE TRIAXIAL DIRECT UNCON, OBSERVATIONS
DENSITY

3-7.2'
Colluvium

7.2-8'
Colluvium

10-12'
Colluvium

13.5-14.7'
Colluvium

NO. 341 M DIETZGEN DESIGN PAT. 2,811,000
MILLIMETER

21-22'
Colluvium

COLLUVIUM
SLIDE

ARAPAHOE FM

7.5%

19.4%

63.4% 43.0

0.55.5°

18.9%

62.6% 40.7

18.4%

Composite
TRIAXIAL
Shear tests
From
71494
56894
71494
59294
for
WEATHERED
UPPER
ARAPAHOE

PORT 1010 712011

Middle of slide

Atterberg
LL
PS - 200 SIEVE

MOISTURE TRIAXIAL DIRECT UNCONF. OBSERVATIONS
DENSITY

25-28'
Claystone

18.5%

UNION CORPORATION

32.8 -
34.3

Claystone

18.6%

V
TD=34.3'

NO. 111-N DETERMINED BY
UNION CORPORATION

BOREHOLE 71296 (CONT.)

(Page 93) Boring 71294

Location: Within "1994 USGS slide" east of east end of landfill, south of SID road.

Mobile B-57

Boyles Brothers

Advanced hole with 3.25" ID Hollow Stem Augers

3" Shelby Tubes

Moss Sampling

Cal Mod drive sampling

water perched at 28' (wet sample from 28'-28.2')

drilled 2/1/95

TD @ 34.3'

(Page 94) Boring 71294

COLLUVIUM/SLIDE

0'-1' GRAVELLY LEAN CLAY (CL):

dark brn.; moist; mod. plastic; grass roots to .3'.

1'-5' SANDY CLAY with GRAVEL (CL):

yellowish-brn., mod. brown; damp;

v. stiff; occ. claystone fragments;

occ. rootlets; gravels to 1"

4.5-5' highly weathered claystone.

claystone smeared along 60°,

slickensided surface against

colluvium, at 5'-5.1'

5'-7.2' SANDY, CLAYEY GRAVEL (GC):

orange-brn.; moist; med. dense; f.

-crs. gravel; occ. cobbles.

0'-2' Moss

rec. 2.0/2.0

2'-4' Cal Mod

24/28/27/26

rec. 2.0/2.0

4'-5.8' Cal Mod

16/27/41/50/3"

rec. 1.1/1.8

cobble (rough drilling)

at 5.8'

drill out to 6'

6' to 8' Cal Mod

25/27/38/32

rec. 2.0/2.0

*Note: 6'-8' Cal Mod

retain bag samples

6'-7.2'

7.2'-8' Claystone

10'-12' push Shelby

(cont'. on next page)

ARAPAHOE FORMATION

7.2'-30.5' CLAYSTONE: gray,

yellowish-brn.; mid-highly wthered

(var.); plastic-friable; soft;

closely fractured; abundant iron

stained fract. surfaces at var.

orientations.

(Page 95) 71294 cont'

7.2'-30.5' claystone cont'

numerous slickensided surfaces at various orientations. Soil

Properties: damp; v. stiff; highly

plastic (CH). Note: 0.25" thick

crushed claystone (gough like),

at 20° dip at 7.8' (possible slide

base?)

Hard below 10'; occ. slickensided

surfaces below 10'; occ. sand-f.

gravel sized iron concretions,

occ. carbonaceous material below

10'.

Predominantly gray, occ. orange

10'-12' push Shelby

rec. 1.7/2.0

push up to 6500#

slight crimp in tube

bottom

pp=4.5+ at 11.7'

12'-13.3' Cal Mod

24/45/50/4"

rec. 1.3/1.3

drill out to 13.5'

13.5'-14.4' Cal Mod

30/50/5"; rec. 0.9/0.9

14.5'-15.3' Cal Mod

40/50/4"; rec. 0.8/0.8

iron staining in ground mass and along fractures; generally less fractured (mod. fractured) below 15'

Appears intensely fractured; some slickensided polished surfaces; softer. Soil Properties: stiff-v. stiff from 17.5'-17.8' (however does not appear disrupted w/ displaced materials

(Page 96) 71294

7.2'-30.5' Claystone cont' predominantly yellowish-brn., mottled orange; damp to moist below 22' (22'-30.5')

v. thinly laminated, some slickensides along horiz. surfs; v. heavy iron staining, from 27'-29'; caliche(?) from 27'-27.5') wet (perched water) from 28'-28.2' hard; iron cemented from 28.5'-28.8' 30.5'-34.3' CLAYSTONE: dark gray; fresh; friable; soft; massive?; some slickensided surfaces, random, observed from 33'-33.5'. Soil Properties: damp; hard; highly plastic (CH).

Hole bottom at 34.3'

drill out to 15.5'
bag sample 13.5'-14.4'
15.5'-17.5' Moss
rec. 2.0/2.0
17.5'-18.3' Cal Mod
27/50/4"; rec. 0.8/0.8
drill out to 18.5'
18.5'-20.5' Moss
rec. 2.0/2.0
20.5'-21' Cal Mod
50/6"; rec. 0.5/0.5

21'-22' Moss
rec. 1.0/1.0; bag samp
22'-24' Moss
rec. 2.0/2.0
24'-26' Moss
rec. 2.0/2.0
bag samp. 25'-26'
26'-28' Moss
rec. 2.0/2.0
28'-28.8' Moss
rec. 0.8/0.8; (v. hard
advance) wet, perched
at 28'
28.8'-30.8' Moss
rec. 2.0/2.0
30.8'-32.8' Moss
rec. 1.0/2.0
32.8'-34.3' Moss
rec. 1.5/1.5
bag samp. 32.8-34.3'
Terminate at 34.3'.

BOREHOLE 71294 LABORATORY SAMPLES

BH00204AS, 71294, Colluvium 6-7.2'

Moisture Content

7.5%

BH00205AS, 71294, Claystone 7.2-8'

Moisture Content

19.4%

*BH00206AS, 71294 (page 314), Claystone 10-12'

12-21" ML

Atterberg Limits Test

LL 63.4% PI 43

6-12" ML, no tests

0-6" ML

Triaxial Compression Test (pore pressure) $c = 0$ $\phi = 55.5$

BH00207AS, 71294, Claystone 13.5-14.4'

Moisture Content

18.9%

BH00208AS, 71294, Claystone 21-22'

Moisture Content

18.4%

Atterberg Limits

LL 62.6% PI 40.7

BH00209AS, 71294, Claystone 25-28'

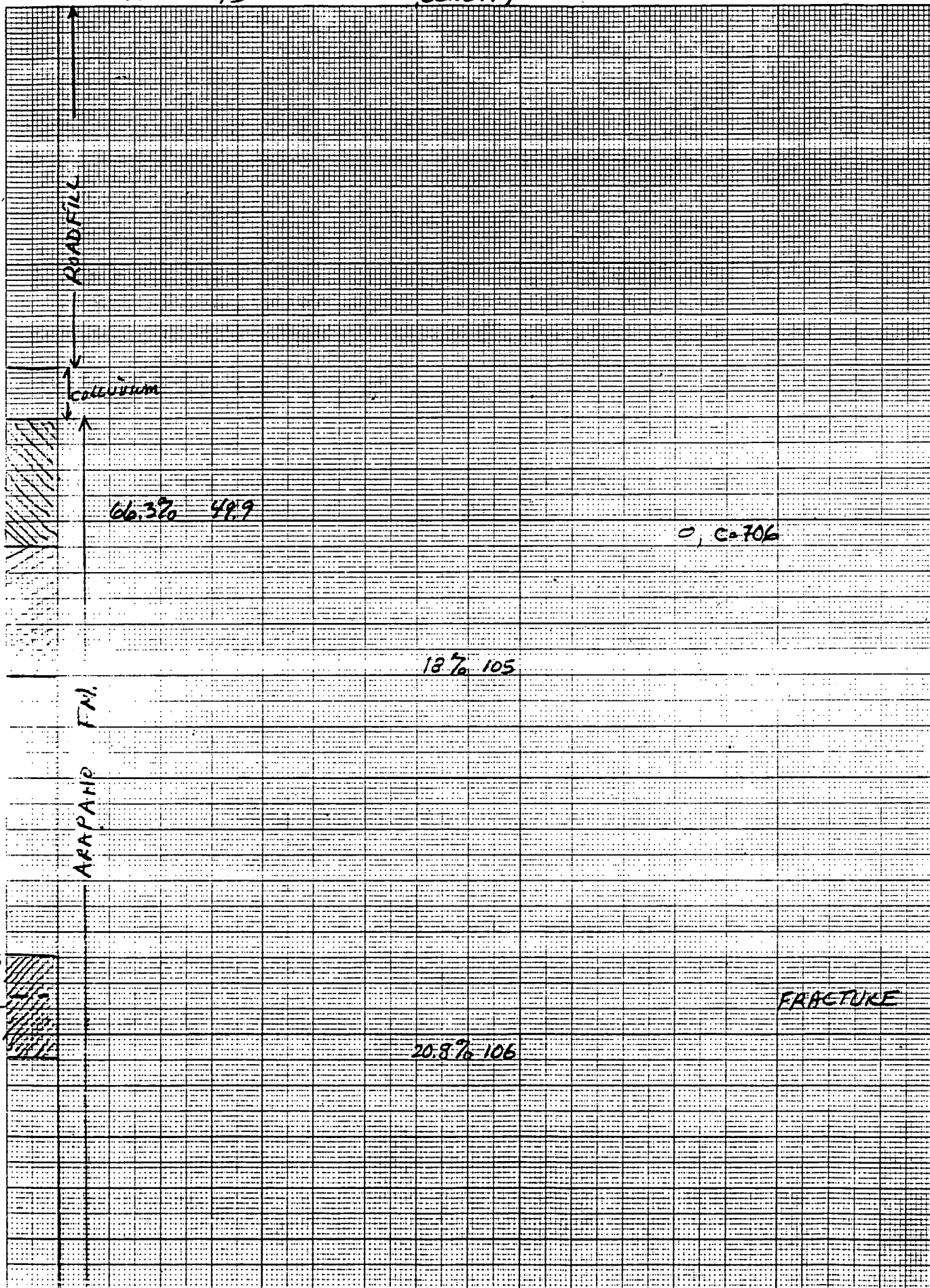
Moisture Content

18.5%

BH00210AS, 71294, Claystone 32.8-34.3'

Moisture Content

18.6%



8-10.5

10.5-13
Claystone

18.5-20.5
Claystone

BOREHOLE 57494

M. 510 of 31.1. 1961

ARAPACOE M

TD=30.5'

BOREHOLE 57494

(Page 47) Boring 57494

Location: S side of E/W road, 230' east of 57094.

Mobile B-57

Boyles Brothers

Drill with 3.25" ID Hollow Stem Augers

Moss Sampling

3" Shelby Tube (push)

Cal Mod drive sampling

water not encountered

drilled 1/5/95

TD @ 36.5'

Grout Backfill on 1/6/95

(Page 48) 57494

ROADFILL Mostly replaced claystone 0'-2' Moss

0'-7' SANDY, GRAVELLY CLAY (CL): rec. 2.0'/2.0'

mod. brn.; moist; v. stiff; f.-crs. 2'-4' Moss

sand, mostly fine gravel. rec. 1.7'/2.0'

H. brn., with some orange gray 4'-6' Moss

mottling; dry to damp below 0.6'. rec. 1.5'-2.0'

6'-8' Cal. Mod

COLLUVIUM 9/13/18/17

7'-8' GRAVELLY CLAY (CH): rec. 1.5'/1.5'

dark brn.; moist; v. stiff; f.-crs.; 8'-10.5' Push Shelby

subangular-subrounded gravel. rec. 2.4'/2.5'

pushed @ approx. 2000#

bottom 0.5 somewhat disturb.

ARAPAHOE FORMATION (sample pushed back into

8'-11' CLAY - CLAYSTONE (CL-CH): tube, was slipping out)

yellowish-brn., mottled orange/gray pp=1.0 tsf @ 10.4'

v. moist; firm-stiff. *Rock 10.5'-13.0' Shelby

Properties: severely weathered; rec. 2.5/2.5'; pp=4.0 @ 13'

plastic; soft. 13'-14.5 Moss

11'-34.3' CLAYSTONE: mottled gray, rec. 1.5/1.5'

yellowish-brn.; mod. weathered; 14.5'-16.5' Moss

plastic-friable; soft. Shows some rec. 1.6/2.0'

fracturing, generally massive. 16.5'-18.5' Moss

Soil Properties: damp; hard; mod.- rec. 2.0/2.0

highly plastic (CL-CH).

Includes some 0.5" iron

concretions @ 18'.

(Page 49) 57494

11'-34.3' CLAYSTONE (cont')

mod.-slightly weathered below 19'

iron concretions at 21.4'

dark gray to black, carbonaceous

from 22.5-23.7'

orange, heavily iron stained,

numerous iron concretions; from

24.5'-26.2'.

18.5'-20.5' Push Shelby

rec. 1.6-2.0'

push up to 8,500 psi

20.5'-22.5' Moss

rec. 1.5/2.0

22.5'-24.5' Moss

rec. 2.0/2.0

24.5'-26.5' Moss

rec. 2.0/2.0

26.5'-28.5' Moss

rec. 1.6/2.0

dark gray to black; carbonaceous
with some iron staining, from
31'-32'.

H. gray, v. little iron staining
below approx. 32.5'

34.3'-36.5' CLAYSTONE: mod. gray;
fresh; friable; soft; massive.

Soil Properties: damp; hard;
(CL-CH).

Terminate at 36.5'

Grout Backfill

28.5'-30.5' Moss

rec. 2.0/2.0

30.5'-32.5' Moss

rec. 2.0/2.0

32.5'-34.5' Moss

rec. 2.0/2.0

34.5'-36.5' Moss

rec. 2.0/2.0

BOREHOLE 57494 LABORATORY SAMPLES

***BH00175AS, 57494 (page 304), Colluvium 8-10.5'**

18-24" CL, no tests

12-18" CL, no tests

6-12" CL

Atterberg Limits Test LL 66.3% PI 49.9

Grain Size Analysis

Hydrometer Analysis

0-6" CL

Unconfined Compressive Strength Test $c = 706$ $\phi = .0$

***BH00176AS, 57494 (page 305), Claystone 10.5-13.1**

20-29" CL, no tests

13-20" CL, no tests

6-13" CL, no tests

0-6" CL

Moisture and Density 18% 105

***BH00177AS, 57494 (page 306), Claystone 18.5-20.5'**

13-20" CL, no tests

fracture at 14.8' *

6-13" CL, no tests

0-6" CL

Moisture and Density 20.8% 106.0

Atterberg
LL PI -200 SIEVE

Moisture
Density

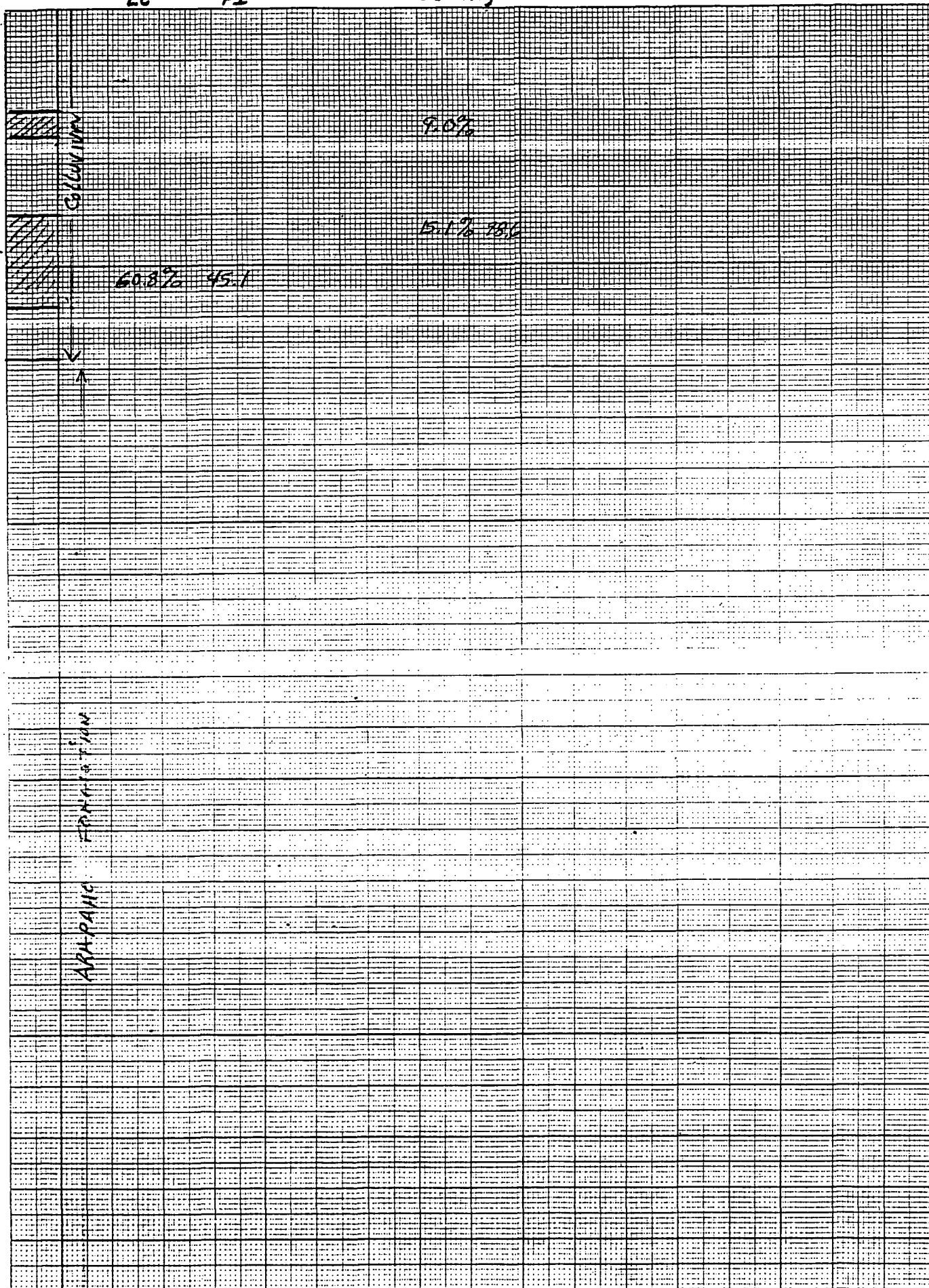
TRIAXIAL DIRECT UNCONF OBSERVATIONS

2.5
COLLUVIUM

4-S.8
COLLUVIUM

DIETZGEN CORPORATION
MADE IN U.S.A.

NO. 341-M DIETZGEN GRAPH PAPER
MILLIMETER



BOREHOLE 57796

(7-2-71)

EUGENE DIEZEL CO.
MADE IN U.S.A.

NO. 10115-1001200N (Lined) and 1001200V (Unlined)

ARRANGE FM

TD-29

BOREHOLE 57794

(Page 16) Boring 57794

Location: Lower (S) slope below west end of landfill; 30' southwest of well 61293.

Mobile B-57 drill

Boyles Brothers

Drill w/ 3.25" ID Hollow Stem Augers

Cal Mod Drive Sampling

Push 3" Shelby Tubes

Moss System

Water not encountered

Drilled 12/6-7/94

TD @ 29'

(Page 17) 57794 cont.

0'-0.1' Topsoil; roots, slty clay

COLLUVIUM

0.1'-6.8' SANDYCLAY (CL): dark brn.

moist; firm; f.-crs. sand, some fine

gravel; occasional roots.

mod. organic to 0.5'

-mod. brn.; damp; stiff;

below 0.5'

v. stiff; mottled orange (heavy

iron staining) below approx. 2'

occasional cobbles below 5.5'

0'-2' Cal Mod

5/13/14/18

rec. 2.0/2.0

2'-4' Cal Mod

17/22/28/27

rec. 2.0/2.0

bag smpl. 2.0-2.5'

4'-5.8' push Shelby

rec. 1.8/1.8

v. hard push; refusal

@ 5.8' bottom of tube

badly dented

6'-8' Cal Mod

30/22/14/21

(eased @ approx. 6.8')

rec. 2.0/2.0

8' 12/6/12/7

8'-10.5' Push Shelby

rec. 2.3/2.5*

pp=3.5 tsf @ 10.3'

10.5'-12.5' Cal Mod

15/21/34/60

rec. 2.0/2.0

*steady push up to

2,500 psi

ARAPAHOE FORMATION

6.8'-8' CLAYSTONE/FAT CLAY (CH):

mottled H. Gray, yellowish brn.;

moist; stiff; "Rock" Properties:

severely weathered; plastic; soft.

approx. 8'-27' CLAYSTONE: mostly

mod. gray, some orange (iron stn.)

mottling; mod. weathered; friable to

plastic; soft; some rounded iron

concretions up to 0.5" ϕ ; massive.

Soil Properties: damp; v. stiff; mod.

(Page 18) 57794 cont.

approx. 8'-27' CLAYSTONE (cont.)

plastic (CL), locally CH

generally lean clay/ "silty

claystone".

slightly less weathered (still

mod.), friable, displays some

fracturing. Soil Properties: hard

(soil) below approx. 14'.

locally displays subhoriz. bedding

laminations, w/ iron stained

surfaces), some carbonaceous

material (charcoal), rare, thin-

v. thin silty sandstone laminae.

12.5'-15' Push Shelby*

rec. 2.5/2.5

pp=4.5+ @ 15'

*push up to 3,300 #'s

(rig down pressure)

15'-17' Moss

rec. 2.0/2.0

17'-19' Moss

rec. 2.0/2.0

19'-21' Moss

rec. 2.0/2.0

21'-23' Moss

harder, damp to moist below 23'

rec. 2.0/2.0

23'-25' Moss

rec. 2.0/2.0

25'-27' Moss

rec. 2.0/2.0

27'-29' CLAYSTONE: mod. gray;
slightly weathered/fresh; friable;
soft; massive. Soil Properties:
damp; hard; mod. plastic; (CL-
"silty claystone").

harder drilling below

approx. 23'

27'-29' Moss

rec. 2.0/2.0

Terminate @ 29'; grout backfill via Tremie.

BOREHOLE 57794 LABORATORY SAMPLES

BH00128AS, 57794, Colluvium 2-2.5'

Moisture Content

9.0%

Visual Classification

*BH00129AS, 57794, (page 285), Colluvium 4-5.8'

12-17" CL/ML

Moisture and Density

15.1%

98.6

6-12" CL/ML

Atterberg limits Test

LL 60.8

PI 45.1

Grain Size Analysis

Hydrometer Test

Specific Gravity

0-6"

Damaged, no test

MOISTURE TRIAXIAL DIRECT UNCON. OBSERVATIONS

45.5
FILL/
Clystone

0,26.5°

DIETZGEN CORPORATION
MADE IN U. S. A.

NO. 341-M DIETZGEN GRAPH PAPER
MILLIMETER

BOREHOLE 71494

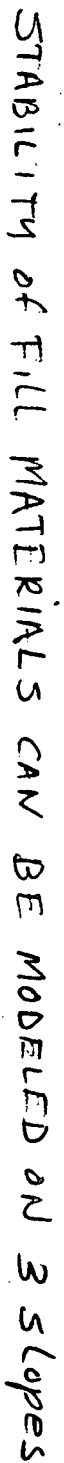
Appendix 5

Conceptual Models

Appendix 6

UTEXAS Models

A



Made in U. S. A.





CROSS-SECTION A-A' CONCEPTUAL MODEL

MOD 1.TXT
 OUTPUT 1.TXT

78.77

$r = 60'$

45.60

20.60

Ground Surface

Fill

$C = 1182$
 $\phi = 0$

Rocky Flats Alluvium

$C = 2000$ psf

$\phi = 17.5$ psf

ARAPAHOE FORMATION

$C = 900$ psf
 $\phi = 22^\circ$

X X X X X X X X

0 60
 20 60
 45 60
 95 34

120

110

100

90

80

70

60

50

40

30

20

10

0

10

20

30

40

50

60

70

80

HEADING

UTEXAS.2 Analysis of OU5 Old Landfill

Cross-section A-A'

Thomas L. McGehee September 1995

PROFILE LINE DATA FOLLOWS

1 1 ground surface

0. 60.

20. 60.

95. 60.

2 2 second ground layer

0. 20.

95. 20.

3 3 embankment

20. 60.

45. 60.

95. 34.

MATERIAL PROPERTY DATA FOLLOWS

1 ground surface

120.0

CONVENTIONAL SHEAR STRENGTHS

2000. 18.

PIEZOMETRIC LINE

1

2 second soil layer

120.0

CONVENTIONAL SHEAR STRENGTHS

0. 22.

PIEZOMETRIC LINE

1

3 FILL MATERIAL

120.0

CONVENTIONAL SHEAR STRENGTHS

1182. 0.

PIEZOMETRIC LINE

1

PIEZOMETRIC LINE DATA FOLLOWS

1 62.4 ASSUMED GROUND WATER CONDITIONS

0. 29.

18. 95.

SLOPE GEOMETRY DATA FOLLOWS

0.0 60.

20. 60.

45. 60.

95. 34.

ANALYSIS AND COMPUTATION DATA

CIRCULAR SEARCH

78. 77. 1. 10.

RADIUS

.

COMPUTE RESULTS

/*

1

Date of this run: 10: 1:1995
 Time of this run: 16:15:39
 UTEXAS2 - VER. 1.208 - 3/ 9/89 - SN00002 - (C) 1985 S. G. WRIGHT
 Date of this run: 10: 1:1995 Time of this run: 16:15:39
 Texas State Department of Highways & Public Transportation
 TABLE NO. 1

 * COMPUTER PROGRAM DESIGNATION - UTEXAS2 *
 * Originally Coded By Stephen G. Wright *
 * Version No. 1.208 *
 * Last Revision Date 3/ 9/89 *
 * Serial No. 00002 *
 * (C) Copyright 1985 Stephen G. Wright *
 * All Rights Reserved *
 * Modified by W. M. Isenhower, 3-9-1989 *
 * SDHPT, Highway Design Division, D-8PD *

 *
 * RESULTS OF COMPUTATIONS PERFORMED USING THIS COMPUTER *
 * PROGRAM SHOULD NOT BE USED FOR DESIGN PURPOSES UNLESS THEY *
 * HAVE BEEN VERIFIED BY INDEPENDENT ANALYSES, EXPERIMENTAL *
 * DATA OR FIELD EXPERIENCE. THE USER SHOULD UNDERSTAND THE *
 * ALGORITHMS AND ANALYTICAL PROCEDURES USED IN THE COMPUTER *
 * PROGRAM AND MUST HAVE READ ALL DOCUMENTATION FOR THIS *
 * PROGRAM BEFORE ATTEMPTING ITS USE. *
 *
 * NEITHER THE UNIVERSITY OF TEXAS NOR STEPHEN G. WRIGHT *
 * MAKE OR ASSUME LIABILITY FOR ANY WARRANTIES, EXPRESSED OR *
 * IMPLIED, CONCERNING THE ACCURACY, RELIABILITY, USEFULNESS *
 * OR ADAPTABILITY OF THIS COMPUTER PROGRAM. *
 *

1

 UTEXAS2 - VER. 1.208 - 3/ 9/89 - SN00002 - (C) 1985 S. G. WRIGHT
 Date of this run: 10: 1:1995 Time of this run: 16:15:39
 Texas State Department of Highways & Public Transportation
 UTEXAS.2 Analysis of OU5 Old Landfill
 Cross-section A-A'
 Thomas L. McGehee September 1995

TABLE NO. 2

 * NEW PROFILE LINE DATA *

PROFILE LINE 1 - MATERIAL TYPE = 1
 ground surface

Point	X	Y
1	.000	60.000
2	20.000	60.000
3	95.000	60.000
4	2.000	2.000
5	.000	20.000
6	95.000	20.000

7	3.000	3.000
8	20.000	60.000
9	45.000	60.000
10	95.000	34.000

1 All new profile lines defined - No old lines retained
 UTEXAS2 - VER. 1.208 - 3/ 9/89 - SN00002 - (C) 1985 S. G. WRIGHT
 Date of this run: 10: 1:1995 Time of this run: 16:15:39
 Texas State Department of Highways & Public Transportation
 UTEXAS.2 Analysis of OU5 Old Landfill
 Cross-section A-A'
 Thomas L. McGehee September 1995

TABLE NO. 3

 • NEW MATERIAL PROPERTY DATA •

DATA FOR MATERIAL TYPE 1
 ground surface

Unit weight of material = 120.000

CONVENTIONAL (ISOTROPIC) SHEAR STRENGTHS

Cohesion - - - - - 2000.000

Friction angle - - - - - 18.000 degrees

Pore water pressures defined by piezometric line

Number of the piezometric line used = 1

Negative pore pressures set to zero

DATA FOR MATERIAL TYPE 2
 second soil layer

Unit weight of material = 120.000

CONVENTIONAL (ISOTROPIC) SHEAR STRENGTHS

Cohesion - - - - - 900.000

Friction angle - - - - - 22.000 degrees

Pore water pressures defined by piezometric line

Number of the piezometric line used = 1

Negative pore pressures set to zero

DATA FOR MATERIAL TYPE 3
 fill material

Unit weight of material = 120.000

CONVENTIONAL (ISOTROPIC) SHEAR STRENGTHS

Cohesion - - - - - 1182.000

Friction angle - - - - - .000 degrees

Pore water pressures defined by piezometric line

Number of the piezometric line used = 1

Negative pore pressures set to zero

1
All new material properties defined - No old data retained
UTEXAS2 - VER. 1.208 - 3/ 9/89 - SN00002 - (C) 1985 S. G. WRIGHT
Date of this run: 10: 1:1995 Time of this run: 16:15:39
Texas State Department of Highways & Public Transportation
UTEXAS.2 Analysis of OU5 Old Landfill
Cross-section A-A'
Thomas L. McGehee September 1995

TABLE NO. 4

* NEW PIEZOMETRIC LINE DATA *

Line

No.	Point	X	Y	
1	-	Unit weight of water =	62.40	ASSUMED GROUND WATER CONDITION
1	1	.000	29.000	ASSUMED GROUND WATER CONDITION
1	2	18.000	95.000	ASSUMED GROUND WATER CONDITION

1
All new piezometric lines defined - No old lines retained
UTEXAS2 - VER. 1.208 - 3/ 9/89 - SN00002 - (C) 1985 S. G. WRIGHT
Date of this run: 10: 1:1995 Time of this run: 16:15:39
Texas State Department of Highways & Public Transportation
UTEXAS.2 Analysis of OU5 Old Landfill
Cross-section A-A'
Thomas L. McGehee September 1995

TABLE NO. 6

* NEW SLOPE GEOMETRY DATA *

All new data input - No old data retained

Slope Coordinates -

Point	X	Y
1	.000	60.000
2	20.000	60.000
3	45.000	60.000
4	95.000	34.000

1
UTEXAS2 - VER. 1.208 - 3/ 9/89 - SN00002 - (C) 1985 S. G. WRIGHT
Date of this run: 10: 1:1995 Time of this run: 16:15:39
Texas State Department of Highways & Public Transportation
UTEXAS.2 Analysis of OU5 Old Landfill
Cross-section A-A'
Thomas L. McGehee September 1995

TABLE NO. 9

* NEW ANALYSIS/COMPUTATION DATA *

Circular Shear Surface(s)

Automatic Search Performed

Starting Center Coordinate for Search at -

X = 78.000
Y = 77.000

Required accuracy for critical center (= minimum
spacing between grid points) = 1.000

Critical shear surface not allowed to pass below Y = 10.000

For the initial mode of search

all circles have the same (constant) radius -

Radius = 60.000

THE FOLLOWING REPRESENT EITHER DEFAULT OR PREVIOUSLY DEFINED VALUES:

Initial trial estimate for the factor of safety = 3.000

Initial trial estimate for side force inclination = 15.000 degrees
(Applicable to Spencer's procedure only)

Maximum number of iterations allowed for
calculating the factor of safety = 40

Allowed force imbalance for convergence = 100.000

Allowed moment imbalance for convergence = 100.000

Initial trial values for factor of safety (and side force inclination
for Spencer's procedure) will be kept constant during search

Maximum subtended angle to be used for subdivision of the
circle into slices = 3.00 degrees

Depth of crack = .000

Search will be continued to locate a more critical shear
surface (if one exists) after the initial mode is complete

Depth of water in crack = .000

Unit weight of water in crack = 62.400

Seismic coefficient = .000

Procedure used to compute the factor of safety: SPENCER

ERROR FOR PROFILE LINE NO. 1 - POINTS OUT-OF-ORDER

POINT 3	X =	95.000	Y =	60.000
POINT 4	X =	2.000	Y =	2.000

ERROR FOR PROFILE LINE NO. 1 - POINTS OUT-OF-ORDER

POINT 4	X =	2.000	Y =	2.000
POINT 5	X =	.000	Y =	20.000

ERROR FOR PROFILE LINE NO. 1 - POINTS OUT-OF-ORDER
POINT 6 X = 95.000 Y = 20.000
POINT 7 X = 3.000 Y = 3.000

CAUTION - DATA FOR MATERIAL TYPE 2 ARE NOT USED

CAUTION - DATA FOR MATERIAL TYPE 3 ARE NOT USED

- - - FATAL ERROR IN DATA - - -

CALCULATIONS NOT POSSIBLE

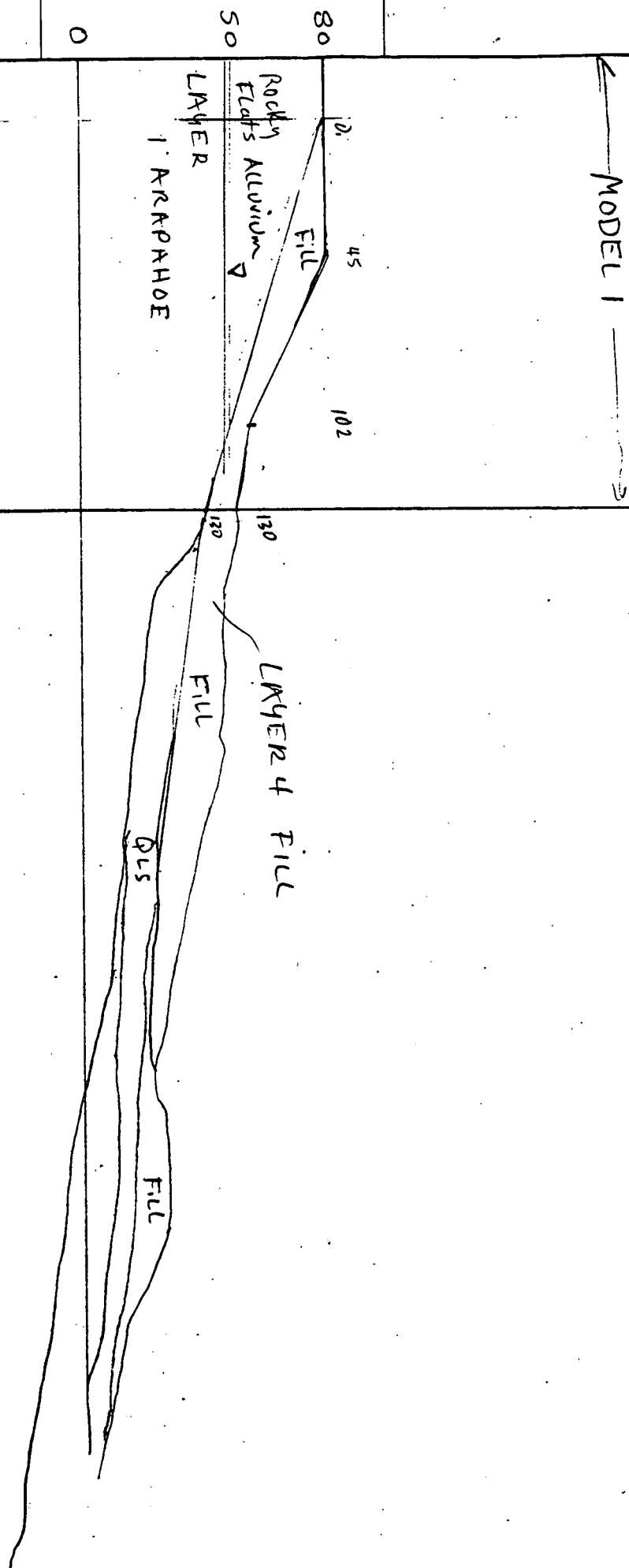
THE PROGRAM WAS ATTEMPTING TO READ A COMMAND WORD AND ENCOUNTERED
AN UNRECOGNIZABLE CHARACTER STRING FOR THE COMMAND WORD

THE LINE OF INPUT = /*

FIRST THREE CHARACTERS INTERPRETED AS '/* '

END-OF-FILE ENCOUNTERED WHILE READING COMMAND
WORDS - END OF PROBLEM(S) ASSUMED

B	CROSS-SECTION B-B'	CONCEPTUAL MODEL



67

CROSS-SECTION B-B

CONCEPTUAL MODEL

65. 67.

TEXT FILE MOD2.TXT
OUTPUT FILE OUTPUT2.TXT

0.50

13.50

58.50

$r=55$

FILL

Rocky Flats Alluvium

AAAPAHOE FM

105.20.

125.20.

125.13.

125.10

125.

0 10 20 30 40 50 60 70 80 90 100 110 120 125

500 SHEETS, FILLER 5 SQUARE
50 SHEETS EYE-GLASS 5 SQUARE
100 SHEETS EYE-GLASS 5 SQUARE
100 SHEETS EYE-GLASS 5 SQUARE
100 SHEETS EYE-GLASS 5 SQUARE
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HEADING

UTEXAS.2 Analysis of OU5 Old Landfill

Cross-section B-B'

Thomas L. McGehee September 1995

PROFILE LINE DATA FOLLOWS

1 1 ground surface

0. 50.

13. 50.

125. 13.

2 2 second ground layer

0. 20.

105. 20.

3 3 embankment

13. 50.

58. 50.

125. 20.

MATERIAL PROPERTY DATA FOLLOWS

1 ground surface

120.0

CONVENTIONAL SHEAR STRENGTHS

2000. 18.

PIEZOMETRIC LINE

1

2 second soil layer

120.0

CONVENTIONAL SHEAR STRENGTHS

0. 22.

PIEZOMETRIC LINE

1

3 FILL MATERIAL

120.0

CONVENTIONAL SHEAR STRENGTHS

1182. 0.

PIEZOMETRIC LINE

1

PIEZOMETRIC LINE DATA FOLLOWS

1 62.4 ASSUMED GROUND WATER CONDITIONS

0. 21.

105. 21.

125. 14.

SLOPE GEOMETRY DATA FOLLOWS

0. 50.

13. 50.

125. 13.

ANALYSIS AND COMPUTATION DATA

CIRCULAR SEARCH

5. 67. 1. 10.

DIUS

55.

COMPUTE RESULTS

/*

1

Date of this run: 10: 1:1995
 Time of this run: 16:47:48
 UTEXAS2 - VER. 1.208 - 3/ 9/89 - SN00002 - (C) 1985 S. G. WRIGHT
 Date of this run: 10: 1:1995 Time of this run: 16:47:48
 Texas State Department of Highways & Public Transportation
 TABLE NO. 1

 * COMPUTER PROGRAM DESIGNATION - UTEXAS2 *
 * Originally Coded By Stephen G. Wright *
 * Version No. 1.208 *
 * Last Revision Date 3/ 9/89 *
 * Serial No. 00002 *
 * (C) Copyright 1985 Stephen G. Wright *
 * All Rights Reserved *
 * Modified by W. M. Isenhower, 3-9-1989 *
 * SDHPT, Highway Design Division, D-8PD *

 *
 * RESULTS OF COMPUTATIONS PERFORMED USING THIS COMPUTER *
 * PROGRAM SHOULD NOT BE USED FOR DESIGN PURPOSES UNLESS THEY *
 * HAVE BEEN VERIFIED BY INDEPENDENT ANALYSES, EXPERIMENTAL *
 * DATA OR FIELD EXPERIENCE. THE USER SHOULD UNDERSTAND THE *
 * ALGORITHMS AND ANALYTICAL PROCEDURES USED IN THE COMPUTER *
 * PROGRAM AND MUST HAVE READ ALL DOCUMENTATION FOR THIS *
 * PROGRAM BEFORE ATTEMPTING ITS USE. *
 *
 * NEITHER THE UNIVERSITY OF TEXAS NOR STEPHEN G. WRIGHT *
 * MAKE OR ASSUME LIABILITY FOR ANY WARRANTIES, EXPRESSED OR *
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 *

1

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 UTEXAS.2 Analysis of OU5 Old Landfill
 Cross-section B-B'
 Thomas L. McGehee September 1995

TABLE NO. 2

 * NEW PROFILE LINE DATA *

PROFILE LINE 1 - MATERIAL TYPE = 1
 ground surface

Point	X	Y
1	.000	50.000
2	13.000	50.000
3	125.000	13.000
4	2.000	2.000
5	.000	20.000
6	105.000	20.000

7	3.000	3.000
8	13.000	50.000
9	58.000	50.000
10	125.000	20.000

1 All new profile lines defined - No old lines retained
 UTEXAS2 - VER. 1.208 - 3/ 9/89 - SN00002 - (C) 1985 S. G. WRIGHT
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 UTEXAS.2 Analysis of OU5 Old Landfill
 Cross-section B-B'
 Thomas L. McGehee September 1995

TABLE NO. 3

 * NEW MATERIAL PROPERTY DATA *

DATA FOR MATERIAL TYPE 1
 ground surface

Unit weight of material = 120.000

CONVENTIONAL (ISOTROPIC) SHEAR STRENGTHS

Cohesion - - - - - 2000.000

Friction angle - - - - - 18.000 degrees

Pore water pressures defined by piezometric line

Number of the piezometric line used = 1

Negative pore pressures set to zero

DATA FOR MATERIAL TYPE 2
 second soil layer

Unit weight of material = 120.000

CONVENTIONAL (ISOTROPIC) SHEAR STRENGTHS

Cohesion - - - - - 900.000

Friction angle - - - - - 22.000 degrees

Pore water pressures defined by piezometric line

Number of the piezometric line used = 1

Negative pore pressures set to zero

DATA FOR MATERIAL TYPE 3
 FILL MATERIAL

Unit weight of material = 120.000

CONVENTIONAL (ISOTROPIC) SHEAR STRENGTHS

Cohesion - - - - - 1182.000

Friction angle - - - - - .000 degrees

Pore water pressures defined by piezometric line

Number of the piezometric line used = 1

Negative pore pressures set to zero

1
All new material properties defined - No old data retained
UTEXAS2 - VER. 1.208 - 3/ 9/89 - SN00002 - (C) 1985 S. G. WRIGHT
Date of this run: 10: 1:1995 Time of this run: 16:47:48
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UTEXAS.2 Analysis of OU5 Old Landfill
Cross-section B-B'
Thomas L. McGehee September 1995

TABLE NO. 4

* NEW PIEZOMETRIC LINE DATA *

Line

No.	Point	X	Y	
1	-	Unit weight of water =	62.40	ASSUMED GROUND WATER CONDITION
1	1	.000	21.000	ASSUMED GROUND WATER CONDITION
1	2	105.000	21.000	ASSUMED GROUND WATER CONDITION
1	3	125.000	14.000	ASSUMED GROUND WATER CONDITION

1
All new piezometric lines defined - No old lines retained
UTEXAS2 - VER. 1.208 - 3/ 9/89 - SN00002 - (C) 1985 S. G. WRIGHT
Date of this run: 10: 1:1995 Time of this run: 16:47:48
Texas State Department of Highways & Public Transportation
UTEXAS.2 Analysis of OU5 Old Landfill
Cross-section B-B'
Thomas L. McGehee September 1995

TABLE NO. 6

* NEW SLOPE GEOMETRY DATA *

All new data input - No old data retained

Slope Coordinates -

Point	X	Y
1	.000	50.000
2	13.000	50.000
3	125.000	13.000

THE PROGRAM WAS ATTEMPTING TO READ A COMMAND WORD AND ENCOUNTERED
AN UNRECOGNIZABLE CHARACTER STRING FOR THE COMMAND WORD

THE LINE OF INPUT =

FIRST THREE CHARACTERS INTERPRETED AS ' '

END-OF-FILE ENCOUNTERED WHILE READING COMMAND
WORDS - END OF PROBLEM(S) ASSUMED

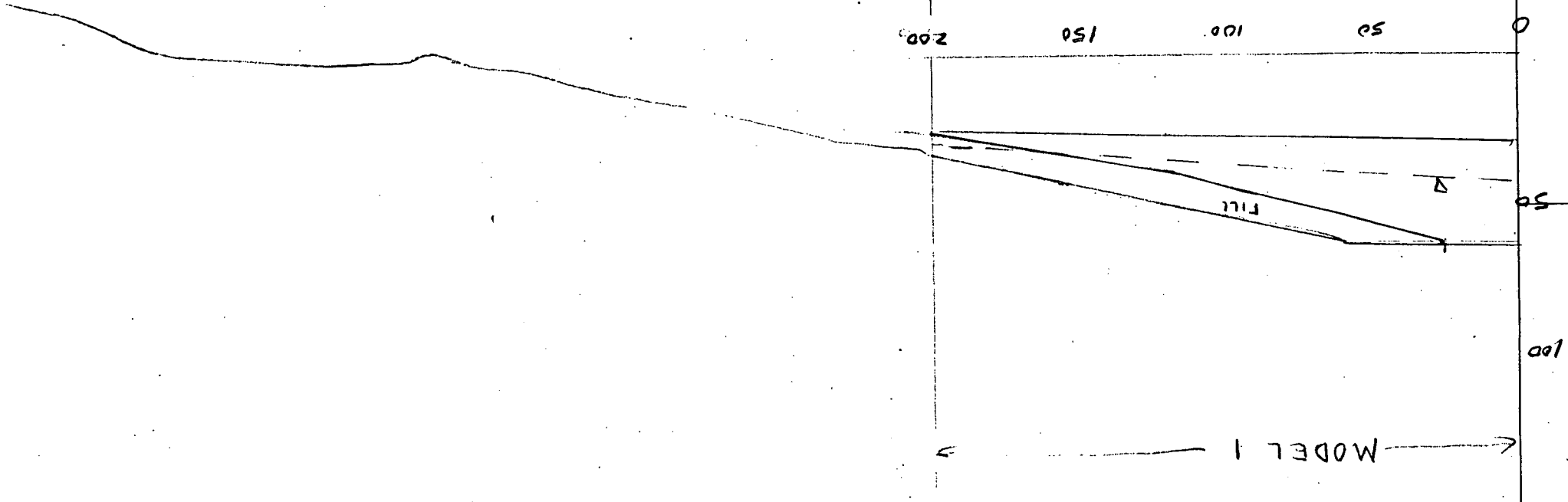


13-782 500 SHEETS, FILLER 5 SQUARE
42-381 50 SHEETS EYE-EASE 5 SQUARE
42-382 100 SHEETS EYE-EASE 5 SQUARE
42-389 200 SHEETS EYE-EASE 5 SQUARE
42-392 100 RECYCLED WHITE 5 SQUARE
42-399 200 RECYCLED WHITE 5 SQUARE
Made in U.S.A.

TEXT FILE
MOD3.TXT
OUTPUT FILE
OUTPUT3.TXT

CROSS-SECTION GC
CONCEPT
MODEL

MODEL 1

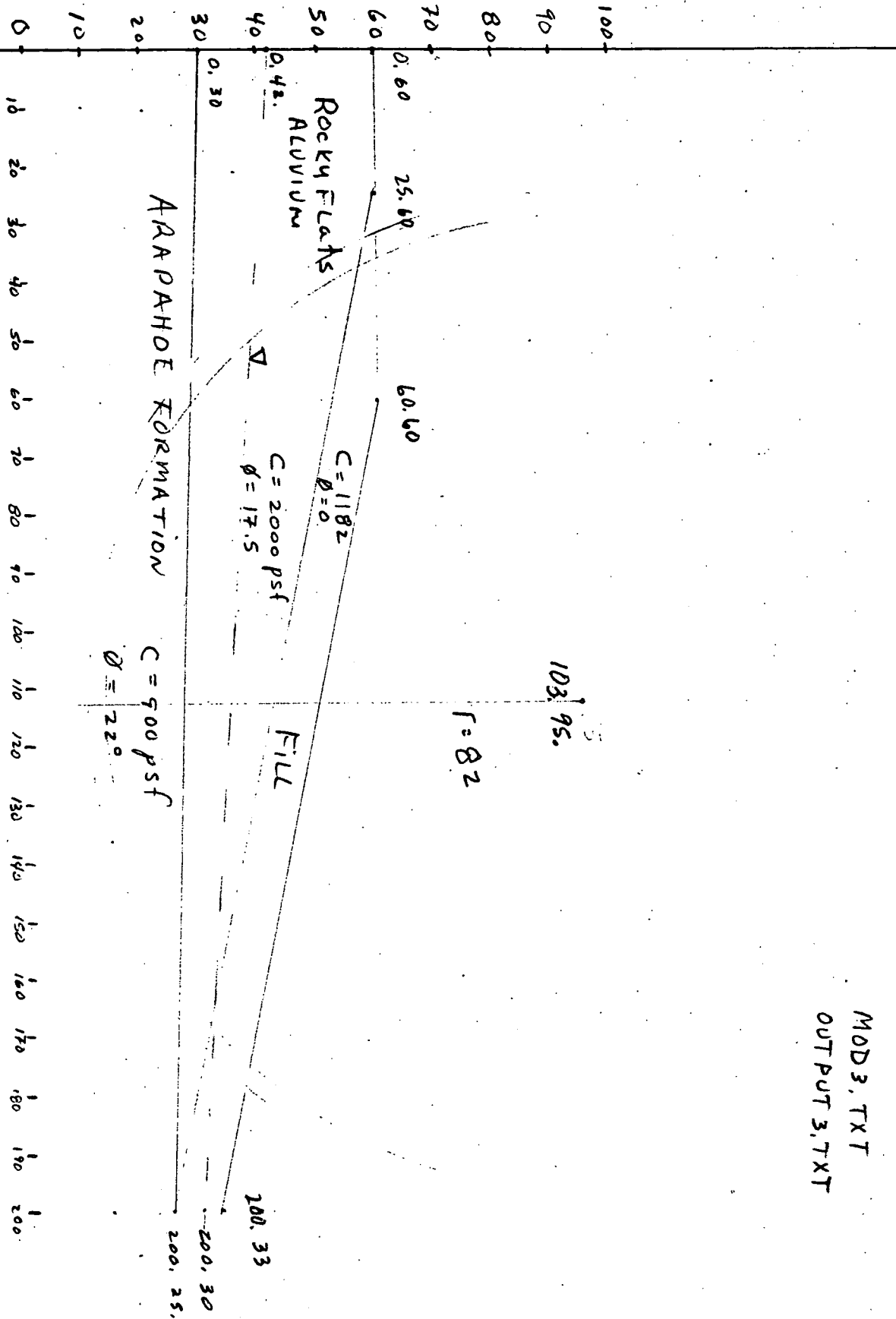




13 302 500 SHEETS, FILLED, 5 SQUARE
42 387 50 SHEETS, NYE EASE, 5 SQUARE
42 382 100 SHEETS, NYE EASE, 5 SQUARE
42 389 200 SHEETS, NYE EASE, 5 SQUARE
42 385 100 SHEETS, NYE EASE, 5 SQUARE
42 386 100 RECYCLED WHITE, 5 SQUARE
Made in U.S.A.

CROSS SECTION C-C' CONCEPTUAL MODEL

MOD3.TXT
OUTPUT3.TXT



HEADING

UTEXAS.2 Analysis of OU5 Old Landfill

Profile-section C-C'

Thomas L. McGehee September 1995

PROFILE LINE DATA FOLLOWS

1 1 ground surface

0. 60.

25. 60.

200. 25.

2 2 second ground layer

0. 30.

200. 25.

3 3 embankment

25. 60.

60. 60.

200. 33.

MATERIAL PROPERTY DATA FOLLOWS

1 ground surface

120.0

CONVENTIONAL SHEAR STRENGTHS

2000. 18.

PIEZOMETRIC LINE

1

2 second soil layer

120.0

CONVENTIONAL SHEAR STRENGTHS

10. 22.

PIEZOMETRIC LINE

1

3 FILL MATERIAL

120.0

CONVENTIONAL SHEAR STRENGTHS

1182. 0.

PIEZOMETRIC LINE

1

PIEZOMETRIC LINE DATA FOLLOWS

1 62.4 ASSUMED GROUND WATER CONDITIONS

0. 29.

18. 95.

SLOPE GEOMETRY DATA FOLLOWS

0. 60.

25. 60.

60. 60.

200. 33.

ANALYSIS AND COMPUTATION DATA

CIRCULAR SEARCH

103. 95. 1. 10.

RADIUS

.

COMPUTE RESULTS

/*

1

Date of this run: 10: 1:1995
 Time of this run: 17:18:32
 UTEXAS2 - VER. 1.208 - 3/ 9/89 - SN00002 - (C) 1985 S. G. WRIGHT
 Date of this run: 10: 1:1995 Time of this run: 17:18:32
 Texas State Department of Highways & Public Transportation
 TABLE NO. 1

 * COMPUTER PROGRAM DESIGNATION - UTEXAS2 *
 * Originally Coded By Stephen G. Wright *
 * Version No. 1.208 *
 * Last Revision Date 3/ 9/89 *
 * Serial No. 00002 *
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 * Modified by W. M. Isenhower, 3-9-1989 *
 * SDHPT, Highway Design Division, D-8PD *

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 *

1

 UTEXAS2 - VER. 1.208 - 3/ 9/89 - SN00002 - (C) 1985 S. G. WRIGHT
 Date of this run: 10: 1:1995 Time of this run: 17:18:32
 Texas State Department of Highways & Public Transportation
 UTEXAS.2 Analysis of OU5 Old Landfill
 Cross-section C-C'
 Thomas L. McGehee September 1995

TABLE NO. 2

 * NEW PROFILE LINE DATA *

PROFILE LINE 1 - MATERIAL TYPE = 1
 ground surface

Point	X	Y
1	.000	60.000
2	25.000	60.000
3	200.000	25.000
4	2.000	2.000
5	.000	30.000
6	200.000	25.000

7	3.000	3.000
8	25.000	60.000
9	60.000	60.000
10	200.000	33.000

1 All new profile lines defined - No old lines retained
 UTEXAS2 - VER. 1.208 - 3/ 9/89 - SN00002 - (C) 1985 S. G. WRIGHT
 Date of this run: 10: 1:1995 Time of this run: 17:18:32
 Texas State Department of Highways & Public Transportation
 UTEXAS.2 Analysis of OU5 Old Landfill
 Cross-section C-C'
 Thomas L. McGehee September 1995

TABLE NO. 3

 * NEW MATERIAL PROPERTY DATA *

DATA FOR MATERIAL TYPE 1
 ground surface

Unit weight of material = 120.000

CONVENTIONAL (ISOTROPIC) SHEAR STRENGTHS

Cohesion - - - - - 2000.000

Friction angle - - - - - 18.000 degrees

Pore water pressures defined by piezometric line

Number of the piezometric line used = 1

Negative pore pressures set to zero

DATA FOR MATERIAL TYPE 2
 second soil layer

Unit weight of material = 120.000

CONVENTIONAL (ISOTROPIC) SHEAR STRENGTHS

Cohesion - - - - - 900.000

Friction angle - - - - - 22.000 degrees

Pore water pressures defined by piezometric line

Number of the piezometric line used = 1

Negative pore pressures set to zero

DATA FOR MATERIAL TYPE 3
 FILL MATERIAL

Unit weight of material = 120.000

CONVENTIONAL (ISOTROPIC) SHEAR STRENGTHS

Cohesion - - - - - 1182.000

Friction angle - - - - - .000 degrees

Pore water pressures defined by piezometric line

Number of the piezometric line used = 1

Negative pore pressures set to zero

1
All new material properties defined - No old data retained
UTEXAS2 - VER. 1.208 - 3/ 9/89 - SN00002 - (C) 1985 S. G. WRIGHT
Date of this run: 10: 1:1995 Time of this run: 17:18:32
Texas State Department of Highways & Public Transportation
UTEXAS.2 Analysis of OU5 Old Landfill
Cross-section C-C'
Thomas L. McGehee September 1995

TABLE NO. 4

* NEW PIEZOMETRIC LINE DATA *

Line

No.	Point	X	Y	
1	-	Unit weight of water =	62.40	ASSUMED GROUND WATER CONDITION
1	1	.000	29.000	ASSUMED GROUND WATER CONDITION
1	2	18.000	95.000	ASSUMED GROUND WATER CONDITION

1
All new piezometric lines defined - No old lines retained
UTEXAS2 - VER. 1.208 - 3/ 9/89 - SN00002 - (C) 1985 S. G. WRIGHT
Date of this run: 10: 1:1995 Time of this run: 17:18:32
Texas State Department of Highways & Public Transportation
UTEXAS.2 Analysis of OU5 Old Landfill
Cross-section C-C'
Thomas L. McGehee September 1995

TABLE NO. 6

* NEW SLOPE GEOMETRY DATA *

All new data input - No old data retained

Slope Coordinates -

Point	X	Y
1	.000	60.000
2	25.000	60.000
3	60.000	60.000
4	200.000	33.000

1
UTEXAS2 - VER. 1.208 - 3/ 9/89 - SN00002 - (C) 1985 S. G. WRIGHT
Date of this run: 10: 1:1995 Time of this run: 17:18:32
Texas State Department of Highways & Public Transportation
UTEXAS.2 Analysis of OU5 Old Landfill
Cross-section C-C'
Thomas L. McGehee September 1995

TABLE NO. 9

* NEW ANALYSIS/COMPUTATION DATA *

Circular Shear Surface(s)

Automatic Search Performed

Starting Center Coordinate for Search at -

X = 103.000
Y = 95.000

Required accuracy for critical center (= minimum spacing between grid points) = 1.000

Critical shear surface not allowed to pass below Y = 10.000

For the initial mode of search

all circles have the same (constant) radius -

Radius = 82.000

THE FOLLOWING REPRESENT EITHER DEFAULT OR PREVIOUSLY DEFINED VALUES:

Initial trial estimate for the factor of safety = 3.000

Initial trial estimate for side force inclination = 15.000 degrees
(Applicable to Spencer's procedure only)

Maximum number of iterations allowed for calculating the factor of safety = 40

Allowed force imbalance for convergence = 100.000

Allowed moment imbalance for convergence = 100.000

Initial trial values for factor of safety (and side force inclination for Spencer's procedure) will be kept constant during search

Maximum subtended angle to be used for subdivision of the circle into slices = 3.00 degrees

Depth of crack = .000

Search will be continued to locate a more critical shear surface (if one exists) after the initial mode is complete

Depth of water in crack = .000

Unit weight of water in crack = 62.400

Seismic coefficient = .000

Procedure used to compute the factor of safety: SPENCER

ERROR FOR PROFILE LINE NO. 1 - POINTS OUT-OF-ORDER

POINT 3	X =	200.000	Y =	25.000
POINT 4	X =	2.000	Y =	2.000

ERROR FOR PROFILE LINE NO. 1 - POINTS OUT-OF-ORDER

POINT 4	X =	2.000	Y =	2.000
POINT 5	X =	.000	Y =	30.000

ERROR FOR PROFILE LINE NO. 1 - POINTS OUT-OF-ORDER
POINT 6 X = 200.000 Y = 25.000
POINT 7 X = 3.000 Y = 3.000

CAUTION - DATA FOR MATERIAL TYPE 2 ARE NOT USED

CAUTION - DATA FOR MATERIAL TYPE 3 ARE NOT USED

- - - FATAL ERROR IN DATA - - -

CALCULATIONS NOT POSSIBLE

THE PROGRAM WAS ATTEMPTING TO READ A COMMAND WORD AND ENCOUNTERED
AN UNRECOGNIZABLE CHARACTER STRING FOR THE COMMAND WORD

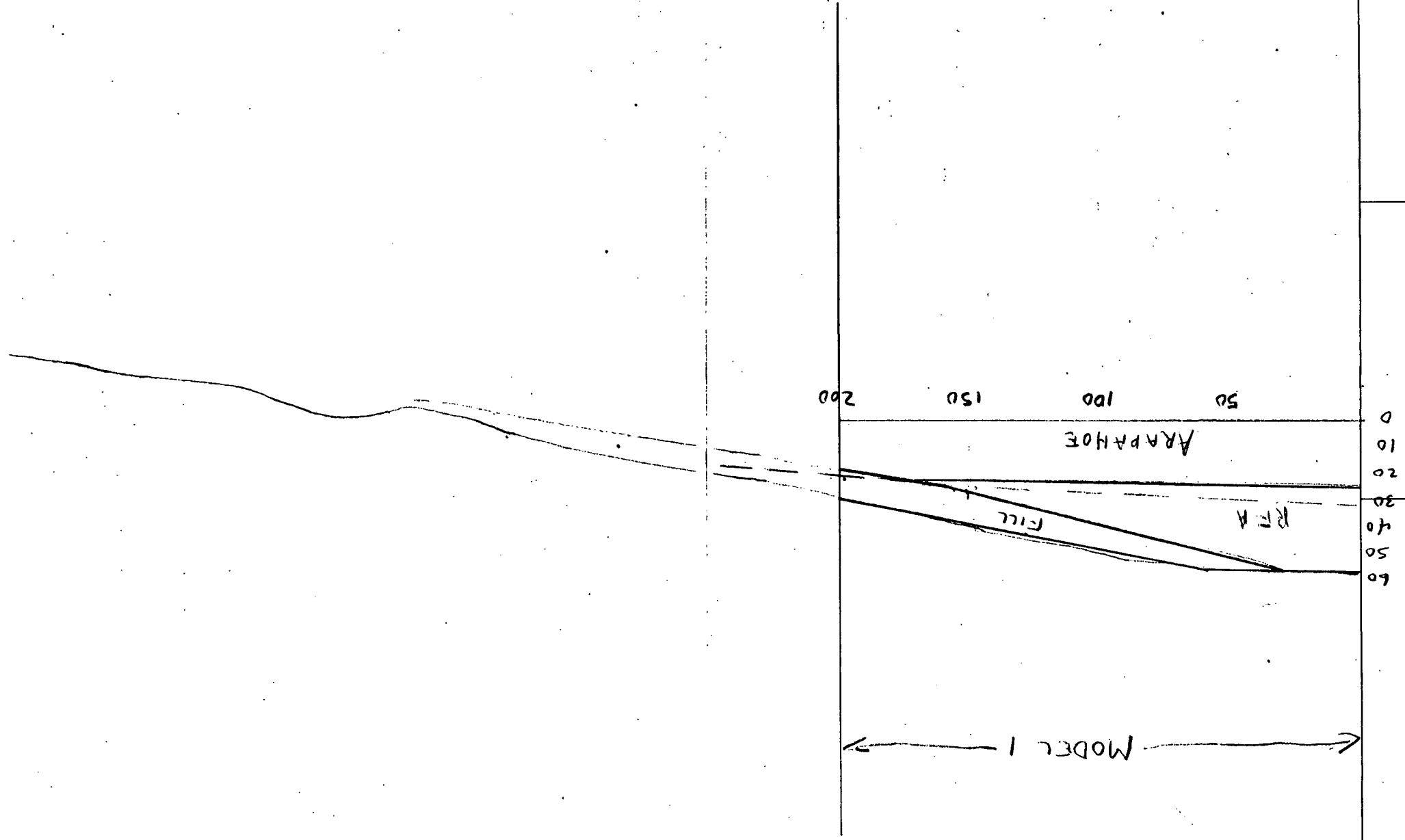
THE LINE OF INPUT = /*

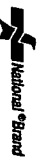
FIRST THREE CHARACTERS INTERPRETED AS '/* '

END-OF-FILE ENCOUNTERED WHILE READING COMMAND
WORDS - END OF PROBLEM(S) ASSUMED



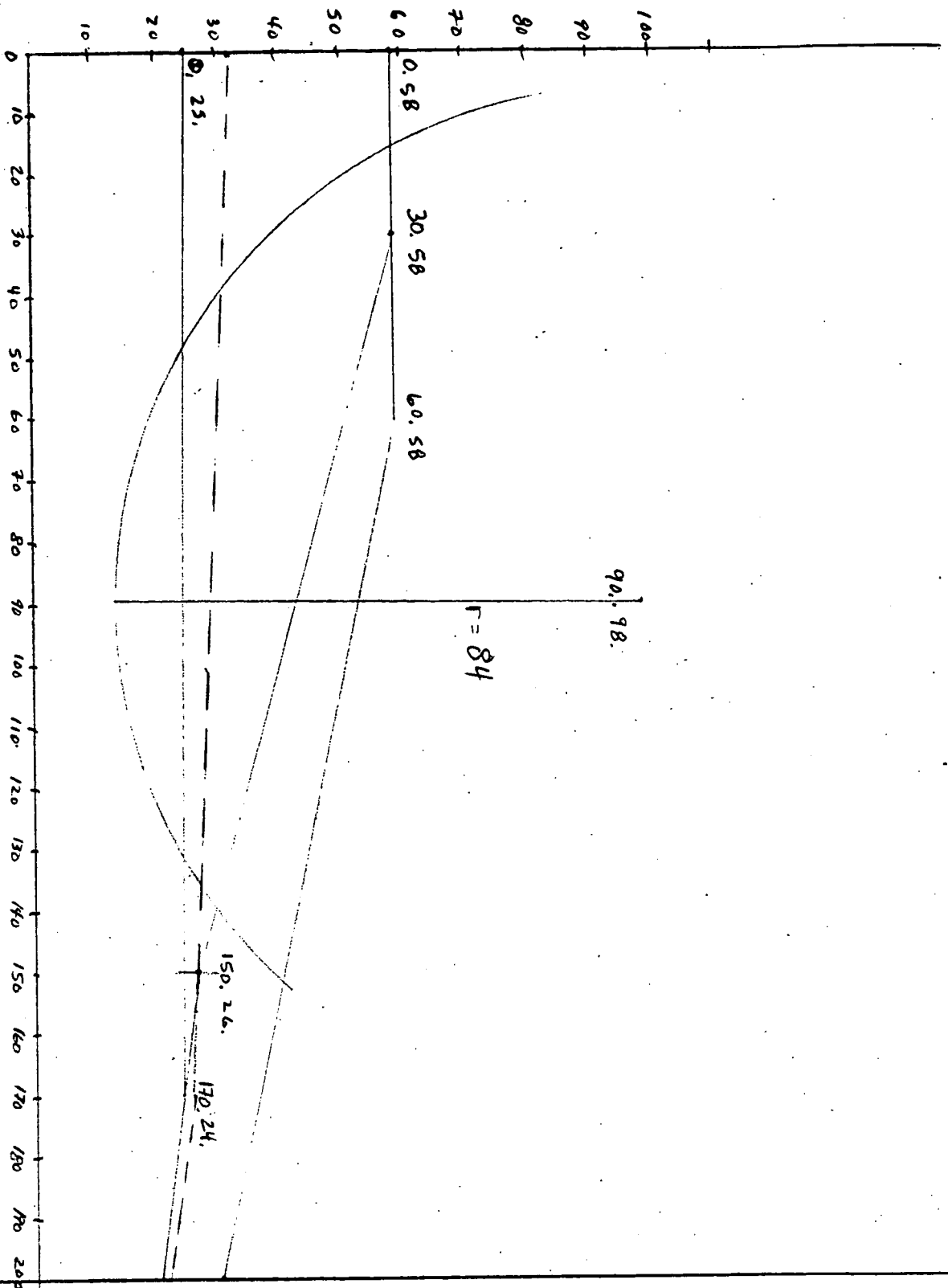
13-782 500 SHEETS, FILLER 5 SQUARE
42-381 50 SHEETS EYE-EASE 5 SQUARE
42-382 100 SHEETS EYE-EASE 5 SQUARE
42-389 200 SHEETS EYE-EASE 5 SQUARE
42-392 100 RECYCLED WHITE 5 SQUARE
42-399 200 RECYCLED WHITE 5 SQUARE
Made in U. S. A.





13-782 300 SHEETS, FILTER, 5 SQUARE
42-382 50 SHEETS, EYE EASE, 5 SQUARE
42-382 100 SHEETS, EYE EASE, 5 SQUARE
42-382 200 SHEETS, EYE EASE, 5 SQUARE
42-382 100 REVOLVED WHITE, 5 SQUARE
42-382 200 REVOLVED WHITE, 5 SQUARE
Made in U.S.A.

Cross-Section D-D' CONCEPTUAL MODEL



MOD4.TXT
OUTP074.TXT

HEADING

UTEXAS.2 Analysis of OU5 Old Landfill

Profile-section C-C'

Thomas L. McGehee September 1995

PROFILE LINE DATA FOLLOWS

1 1 ground surface

0. 58.

30. 58.

150. 26.

200. 20.

2 2 second ground layer

0. 25.

170. 24.

3 3 embankment

30. 58.

60. 58.

200. 30.

MATERIAL PROPERTY DATA FOLLOWS

1 ground surface

120.0

CONVENTIONAL SHEAR STRENGTHS

2000. 18.

PIEZOMETRIC LINE

1

2 second soil layer

120.0

CONVENTIONAL SHEAR STRENGTHS

900. 22.

PIEZOMETRIC LINE

1

3 FILL MATERIAL

120.0

CONVENTIONAL SHEAR STRENGTHS

1182. 0.

PIEZOMETRIC LINE

1

PIEZOMETRIC LINE DATA FOLLOWS

1 62.4 ASSUMED GROUND WATER CONDITIONS

0. 32.

170. 25.

200. 22.

SLOPE GEOMETRY DATA FOLLOWS

0. 58.

30. 58.

60. 58.

200. 30.

ANALYSIS AND COMPUTATION DATA

CIRCULAR SEARCH

98. 1. 10.

DIUS

84.

COMPUTE RESULTS

1

Date of this run: 10: 1:1995
 Time of this run: 17:46:40
 UTEXAS2 - VER. 1.208 - 3/ 9/89 - SN00002 - (C) 1985 S. G. WRIGHT
 Date of this run: 10: 1:1995 Time of this run: 17:46:40
 Texas State Department of Highways & Public Transportation
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1

UTEXAS2 - VER. 1.208 - 3/ 9/89 - SN00002 - (C) 1985 S. G. WRIGHT
 Date of this run: 10: 1:1995 Time of this run: 17:46:40
 Texas State Department of Highways & Public Transportation
 UTEXAS.2 Analysis of OU5 Old Landfill
 Cross-section C-C'
 Thomas L. McGehee September 1995

TABLE NO. 2

 * NEW PROFILE LINE DATA *

PROFILE LINE 1 - MATERIAL TYPE = 1
 ground surface

Point	X	Y
1	.000	58.000
2	30.000	58.000
3	150.000	26.000
4	200.000	20.000
5	2.000	2.000
6	.000	25.000

7	170.000	24.000
8	3.000	3.000
9	30.000	58.000
10	60.000	58.000
11	200.000	30.000

1 All new profile lines defined - No old lines retained
 UTEXAS2 - VER. 1.208 - 3/ 9/89 - SN00002 - (C) 1985 S. G. WRIGHT
 Date of this run: 10: 1:1995 Time of this run: 17:46:40
 Texas State Department of Highways & Public Transportation
 UTEXAS.2 Analysis of OU5 Old Landfill
 Cross-section C-C⁰
 Thomas L. McGehee September 1995

TABLE NO. 3

 * NEW MATERIAL PROPERTY DATA *

DATA FOR MATERIAL TYPE 1
 ground surface

Unit weight of material = 120.000

CONVENTIONAL (ISOTROPIC) SHEAR STRENGTHS

Cohesion - - - - - 2000.000

Friction angle - - - - - 18.000 degrees

Pore water pressures defined by piezometric line

Number of the piezometric line used = 1

Negative pore pressures set to zero

DATA FOR MATERIAL TYPE 2
 second soil layer

Unit weight of material = 120.000

CONVENTIONAL (ISOTROPIC) SHEAR STRENGTHS

Cohesion - - - - - 900.000

Friction angle - - - - - 22.000 degrees

Pore water pressures defined by piezometric line

Number of the piezometric line used = 1

Negative pore pressures set to zero

DATA FOR MATERIAL TYPE 3
 FILL MATERIAL

Unit weight of material = 120.000

CONVENTIONAL (ISOTROPIC) SHEAR STRENGTHS

Cohesion - - - - - 1182.000

Friction angle - - - - - .000 degrees

Pore water pressures defined by piezometric line

Number of the piezometric line used = 1

Negative pore pressures set to zero

All new material properties defined - No old data retained
 UTEXAS2 - VER. 1.208 - 3/ 9/89 - SN00002 - (C) 1985 S. G. WRIGHT
 Date of this run: 10: 1:1995 Time of this run: 17:46:40
 Texas State Department of Highways & Public Transportation
 UTEXAS.2 Analysis of OU5 Old Landfill
 Cross-section C-C'
 Thomas L. McGehee September 1995

TABLE NO. 4

 * NEW PIEZOMETRIC LINE DATA *

Line

No.	Point	X	Y	
1	-	Unit weight of water =	62.40	ASSUMED GROUND WATER CONDITION
1	1	.000	32.000	ASSUMED GROUND WATER CONDITION
1	2	170.000	25.000	ASSUMED GROUND WATER CONDITION
1	3	200.000	22.000	ASSUMED GROUND WATER CONDITION

NO NUMERICAL VALUE INPUT TO DESIGNATE THE NUMBER OF THE
 PIEZOMETRIC LINE WHICH IS BEING (TO BE) DEFINED
 0 VALUE(S) WAS/WERE INPUT - 1 IS/ARE REQUIRED
 THE ERROR WAS DETECTED FOR THE FOLLOWING LINE OF INPUT

SLOPE GEOMETRY DATA FOLLOWS

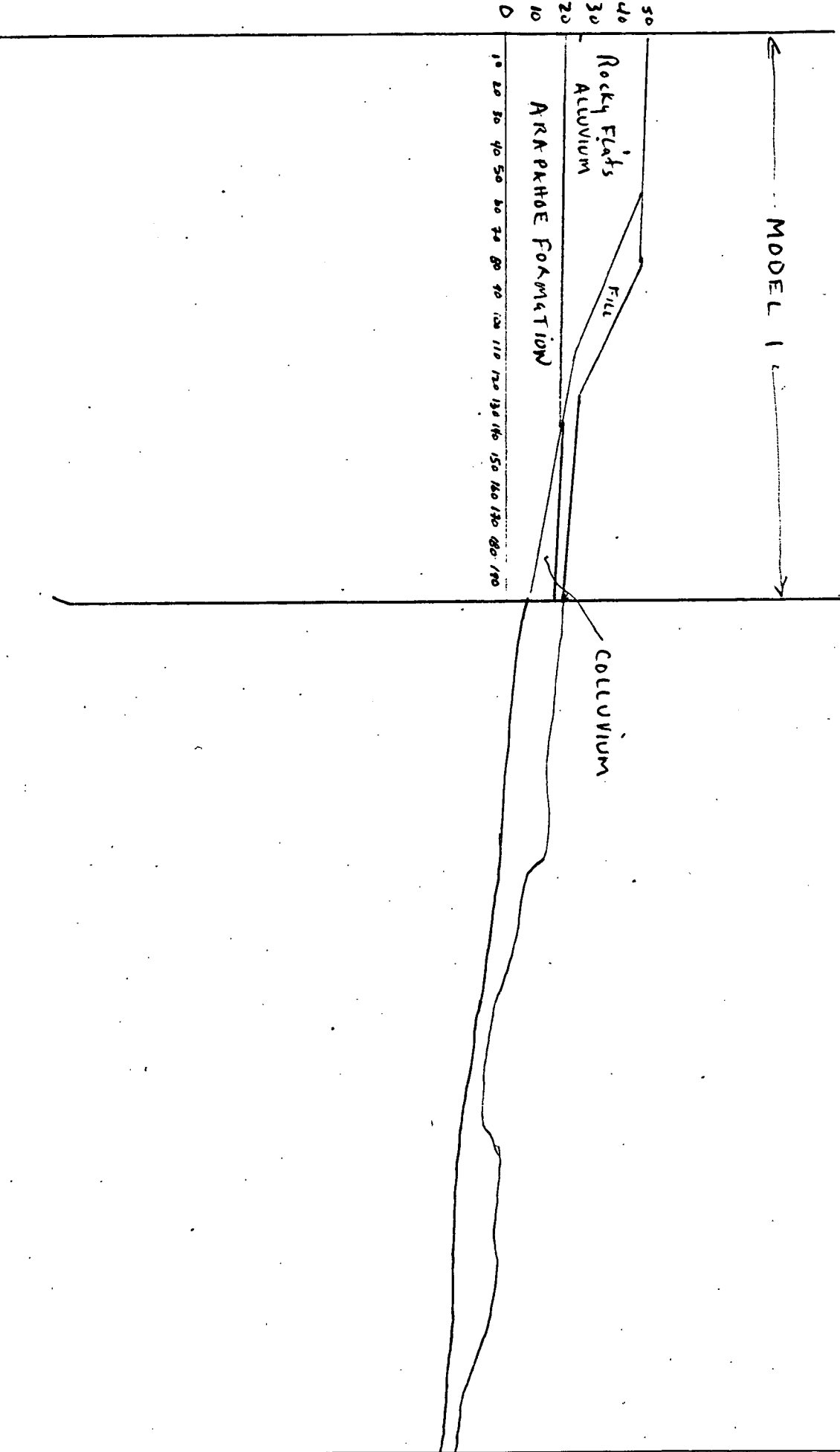
NOTE - TWO BLANK LINES REQUIRED TO TERMINATE
 ALL PIEZOMETRIC LINE DATA

END-OF-FILE ENCOUNTERED WHILE READING COMMAND
 WORDS - END OF PROBLEM(S) ASSUMED

CROSS-SECTION E-E' CONCEPTUAL MODEL



13-782 500 SHEETS, TILED 1 SQUARE
 42-281 500 SHEETS, EASE 1 SQUARE
 42-282 100 SHEETS, EYE EASE 1 SQUARE
 42-283 200 SHEETS, EYE EASE 1 SQUARE
 42-284 100 RECYCLED WHITE 1 SQUARE
 42-285 200 RECYCLED WHITE 1 SQUARE
 Made in U.S.A.

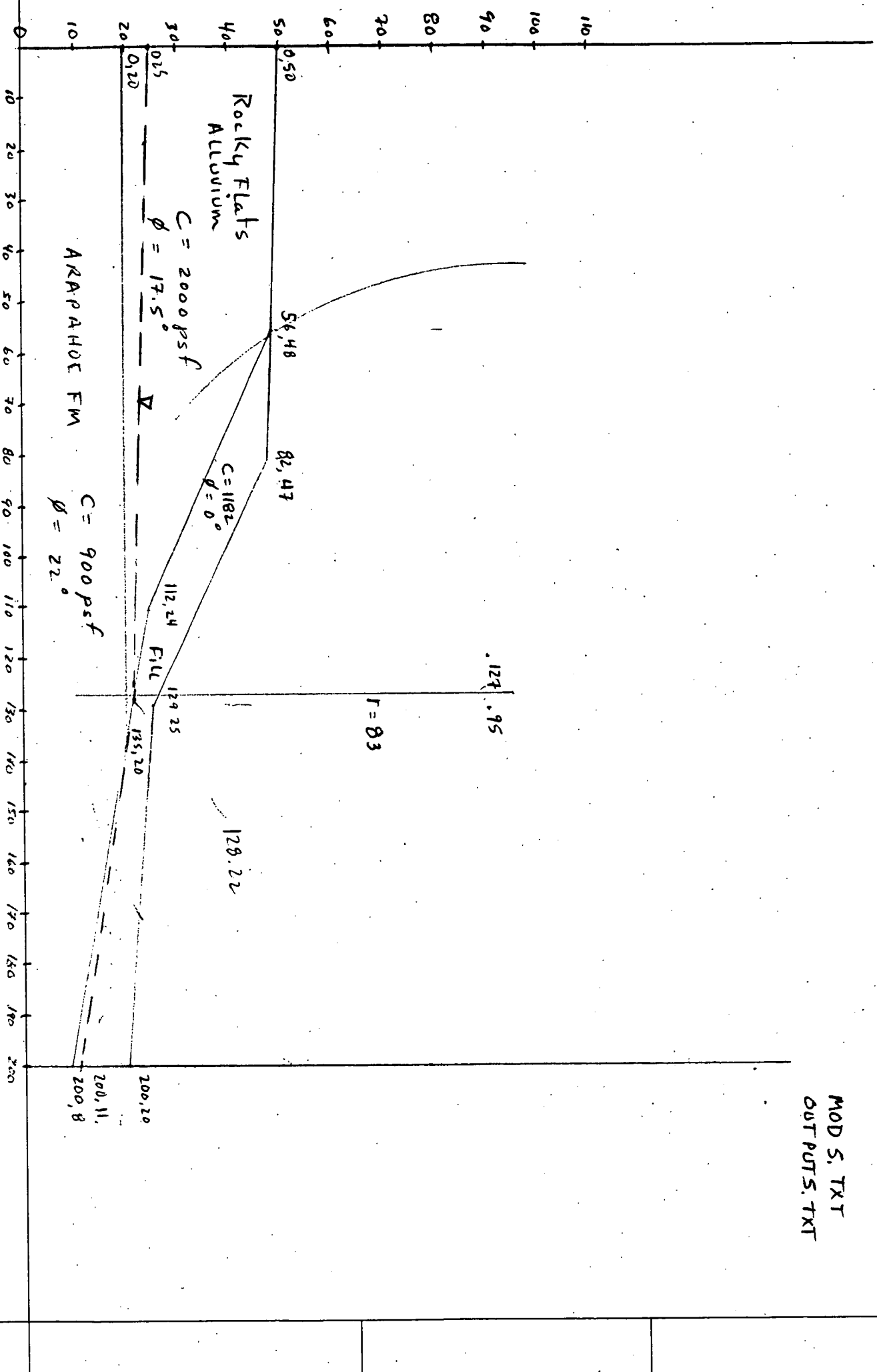


CROSS-SECTION E-E' CONCEPTUAL MODEL



13,782 500 SHEETS, FILTER 5 SQUARE
 42,381 50 SHEETS EYE EASE 3 SQUARE
 42,382 100 SHEETS EYE EASE 3 SQUARE
 42,383 100 SHEETS EYE EASE 3 SQUARE
 42,384 100 SHEETS EYE EASE 3 SQUARE
 42,385 100 RECYCLED WHITE 5 SQUARE
 42,386 200 RECYCLED WHITE 5 SQUARE
 Made in U.S.A.

MOD 5, TXT
 OUTPUTS, TXT



HEADING

UTEXAS.2 Analysis of OU5 Old Landfill

Cross-section E-E'

Thomas L. McGehee September 1995

PROFILE LINE DATA FOLLOWS

1 1 ground surface

0. 50.

56. 48.

112. 24.

200. 8.

2 2 second ground layer

0. 20.

135. 20.

200. 8.

3 3 embankment

56. 48.

82. 47.

129. 25.

200. 20.

MATERIAL PROPERTY DATA FOLLOWS

1 ground surface

120.0

CONVENTIONAL SHEAR STRENGTHS

2000. 18.

PIEZOMETRIC LINE

1

2 second soil layer

120.0

CONVENTIONAL SHEAR STRENGTHS

900. 22.

PIEZOMETRIC LINE

1

3 FILL MATERIAL

120.0

CONVENTIONAL SHEAR STRENGTHS

1182. 0.

PIEZOMETRIC LINE

1

PIEZOMETRIC LINE DATA FOLLOWS

1 62.4 ASSUMED GROUND WATER CONDITIONS

0. 29.

18. 95.

SLOPE GEOMETRY DATA FOLLOWS

0. 50.

56. 48.

82. 47.

129. 25.

200. 20.

ANALYSIS AND COMPUTATION DATA
CIRCULAR SEARCH

127. 95. 1. 10.

RADIUS

COMPUTE RESULTS

/*

1

Date of this run: 10: 1:1995
 Time of this run: 18:20:58
 UTEXAS2 - VER. 1.208 - 3/ 9/89 - SN00002 - (C) 1985 S. G. WRIGHT
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 Texas State Department of Highways & Public Transportation
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 UTEXAS2 - VER. 1.208 - 3/ 9/89 - SN00002 - (C) 1985 S. G. WRIGHT
 Date of this run: 10: 1:1995 Time of this run: 18:20:58
 Texas State Department of Highways & Public Transportation
 UTEXAS.2 Analysis of OU5 Old Landfill
 Cross-section E-E'
 Thomas L. McGehee September 1995

TABLE NO. 2

 * NEW PROFILE LINE DATA *

PROFILE LINE 1 - MATERIAL TYPE = 1
 ground surface

Point	X	Y
1	.000	50.000
2	56.000	48.000
3	112.000	24.000
4	200.000	8.000
5	2.000	2.000
6	.000	20.000

7	135.000	20.000
8	200.000	8.000
9	3.000	3.000
10	56.000	48.000
11	82.000	47.000
12	129.000	25.000
13	200.000	20.000

1

All new profile lines defined - No old lines retained
 UTEXAS2 - VER. 1.208 - 3/ 9/89 - SN00002 - (C) 1985 S. G. WRIGHT
 Date of this run: 10: 1:1995 Time of this run: 18:20:58
 Texas State Department of Highways & Public Transportation
 UTEXAS.2 Analysis of OU5 Old Landfill
 Cross-section E-E'
 Thomas L. McGehee September 1995

TABLE NO. 3

 * NEW MATERIAL PROPERTY DATA *

DATA FOR MATERIAL TYPE 1
 ground surface

Unit weight of material = 120.000

CONVENTIONAL (ISOTROPIC) SHEAR STRENGTHS

Cohesion - - - - - 2000.000

Friction angle - - - - - 18.000 degrees

Pore water pressures defined by piezometric line

Number of the piezometric line used = 1

Negative pore pressures set to zero

DATA FOR MATERIAL TYPE 2
 second soil layer

Unit weight of material = 120.000

CONVENTIONAL (ISOTROPIC) SHEAR STRENGTHS

Cohesion - - - - - 900.000

Friction angle - - - - - 22.000 degrees

Pore water pressures defined by piezometric line

Number of the piezometric line used = 1

Negative pore pressures set to zero

DATA FOR MATERIAL TYPE 3
 FILL MATERIAL

Unit weight of material = 120.000

CONVENTIONAL (ISOTROPIC) SHEAR STRENGTHS

Cohesion - - - - - 1182.000

Friction angle - - - - - .000 degrees

Pore water pressures defined by piezometric line

Number of the piezometric line used = 1
Negative pore pressures set to zero

All new material properties defined - No old data retained
UTEXAS2 - VER. 1.208 - 3/ 9/89 - SN00002 - (C) 1985 S. G. WRIGHT
Date of this run: 10: 1:1995 Time of this run: 18:20:58
Texas State Department of Highways & Public Transportation
UTEXAS.2 Analysis of OU5 Old Landfill
Cross-section E-E'
Thomas L. McGehee September 1995

TABLE NO. 4

* NEW PIEZOMETRIC LINE DATA *

Line No.	Point	X	Y	
1	-	Unit weight of water =	62.40	ASSUMED GROUND WATER CONDITION
1	1	.000	29.000	ASSUMED GROUND WATER CONDITION
1	2	18.000	95.000	ASSUMED GROUND WATER CONDITION

All new piezometric lines defined - No old lines retained
UTEXAS2 - VER. 1.208 - 3/ 9/89 - SN00002 - (C) 1985 S. G. WRIGHT
Date of this run: 10: 1:1995 Time of this run: 18:20:58
Texas State Department of Highways & Public Transportation
UTEXAS.2 Analysis of OU5 Old Landfill
Cross-section E-E'
Thomas L. McGehee September 1995

TABLE NO. 6

* NEW SLOPE GEOMETRY DATA *

All new data input - No old data retained
Slope Coordinates -

Point	X	Y
1	.000	50.000
2	56.000	48.000
3	82.000	47.000
4	129.000	25.000
5	200.000	20.000

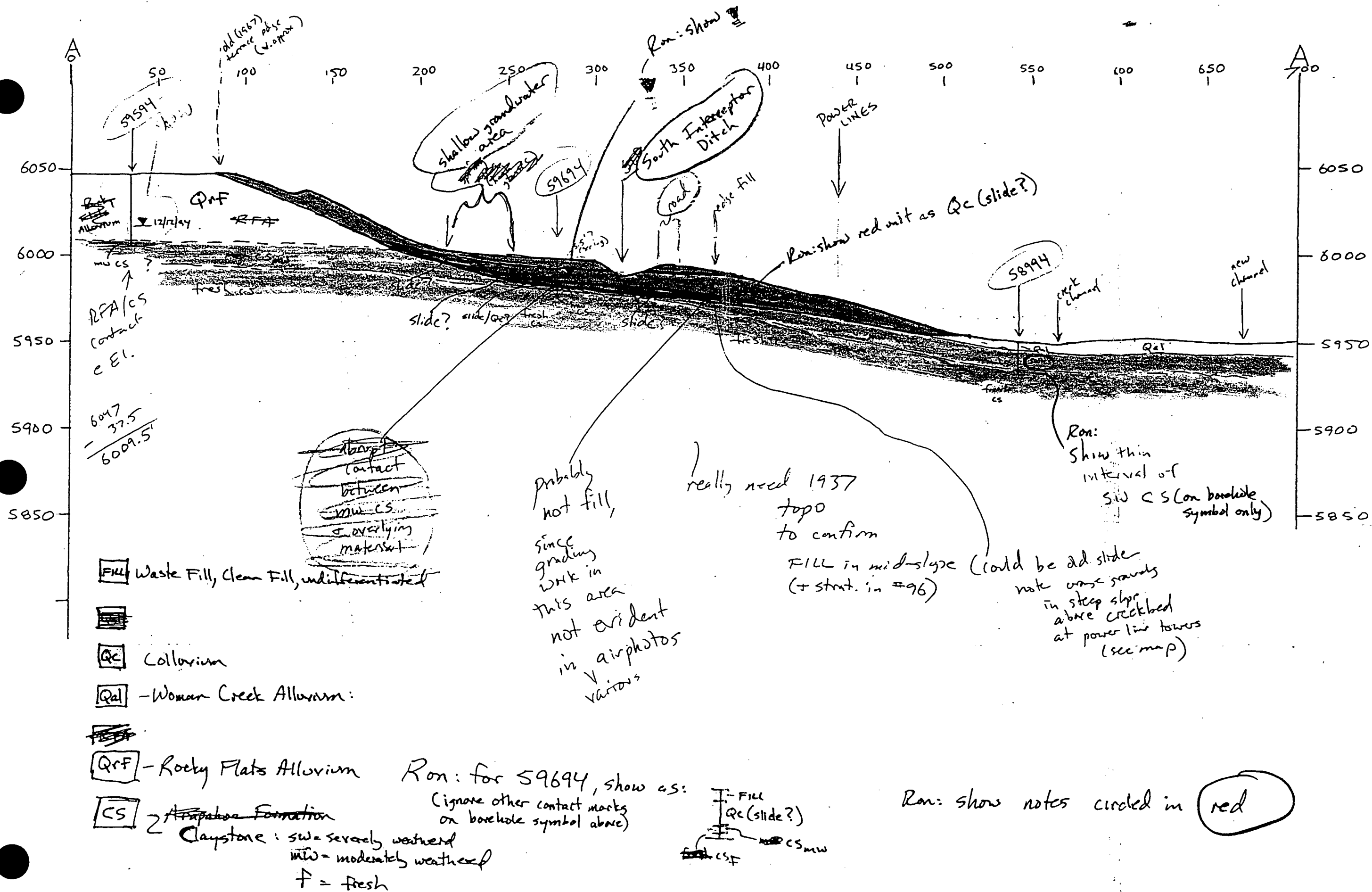
THE PROGRAM WAS ATTEMPTING TO READ A COMMAND WORD AND ENCOUNTERED
AN UNRECOGNIZABLE CHARACTER STRING FOR THE COMMAND WORD

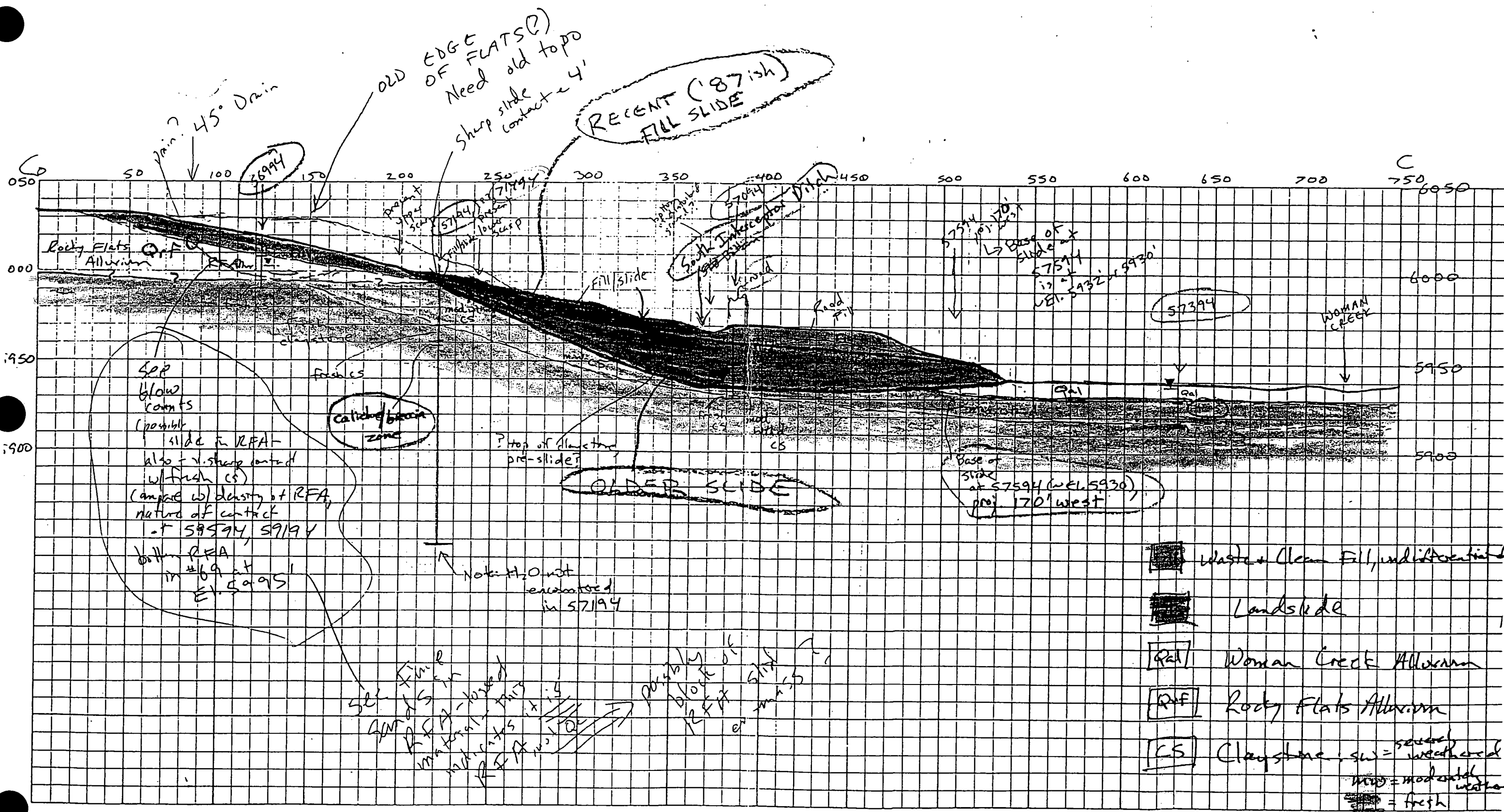
THE LINE OF INPUT -

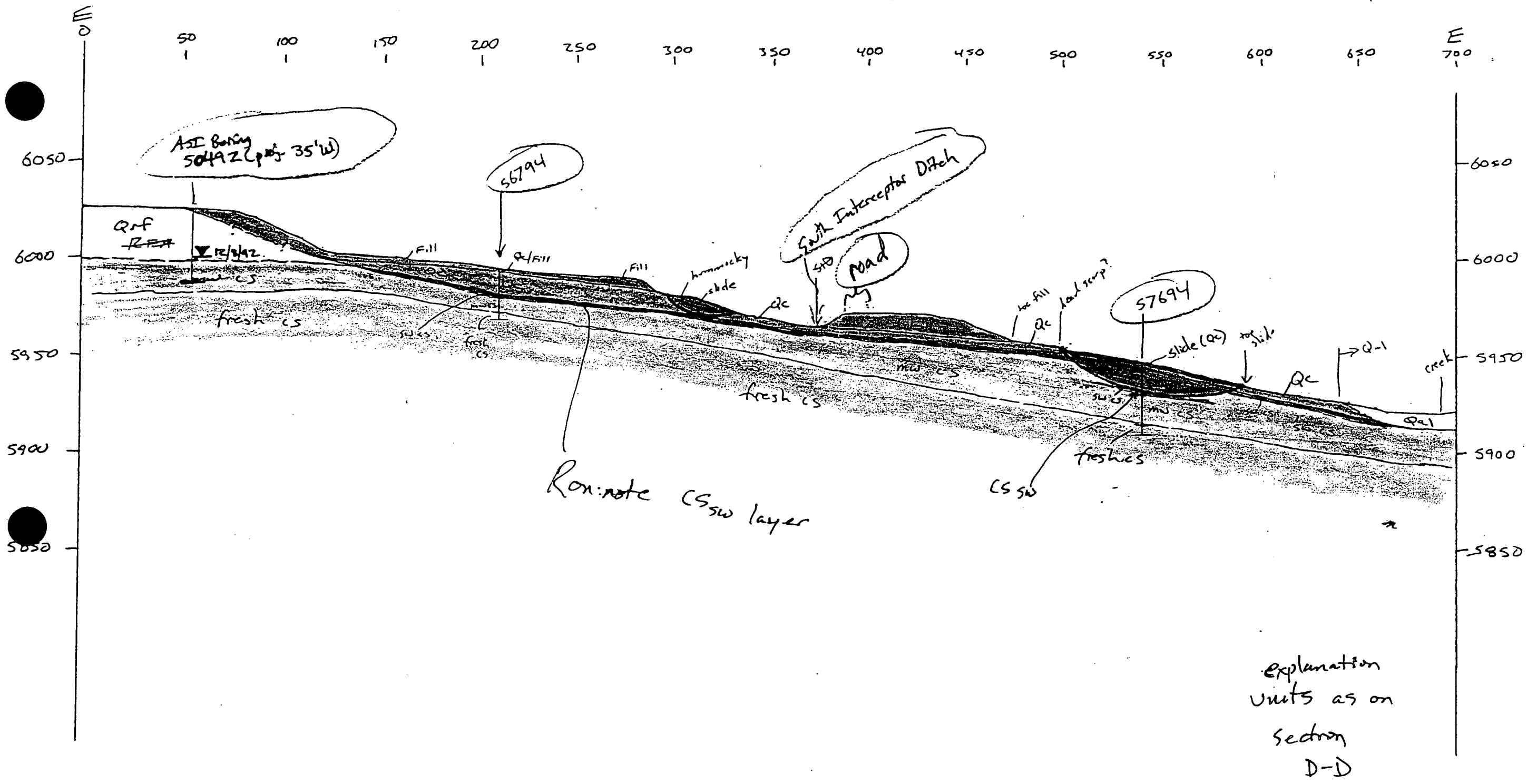
FIRST THREE CHARACTERS INTERPRETED AS ' '

END-OF-FILE ENCOUNTERED WHILE READING COMMAND

WORDS - END OF PROBLEM(S) ASSUMED







Explanation
units as on
section
D-D

5980

WCMAN

14

portion of
alignment of
abandoned gas
line



11
Location of
landslide,
airphoto

approx. location of
apparent landslide,
1951 airphoto

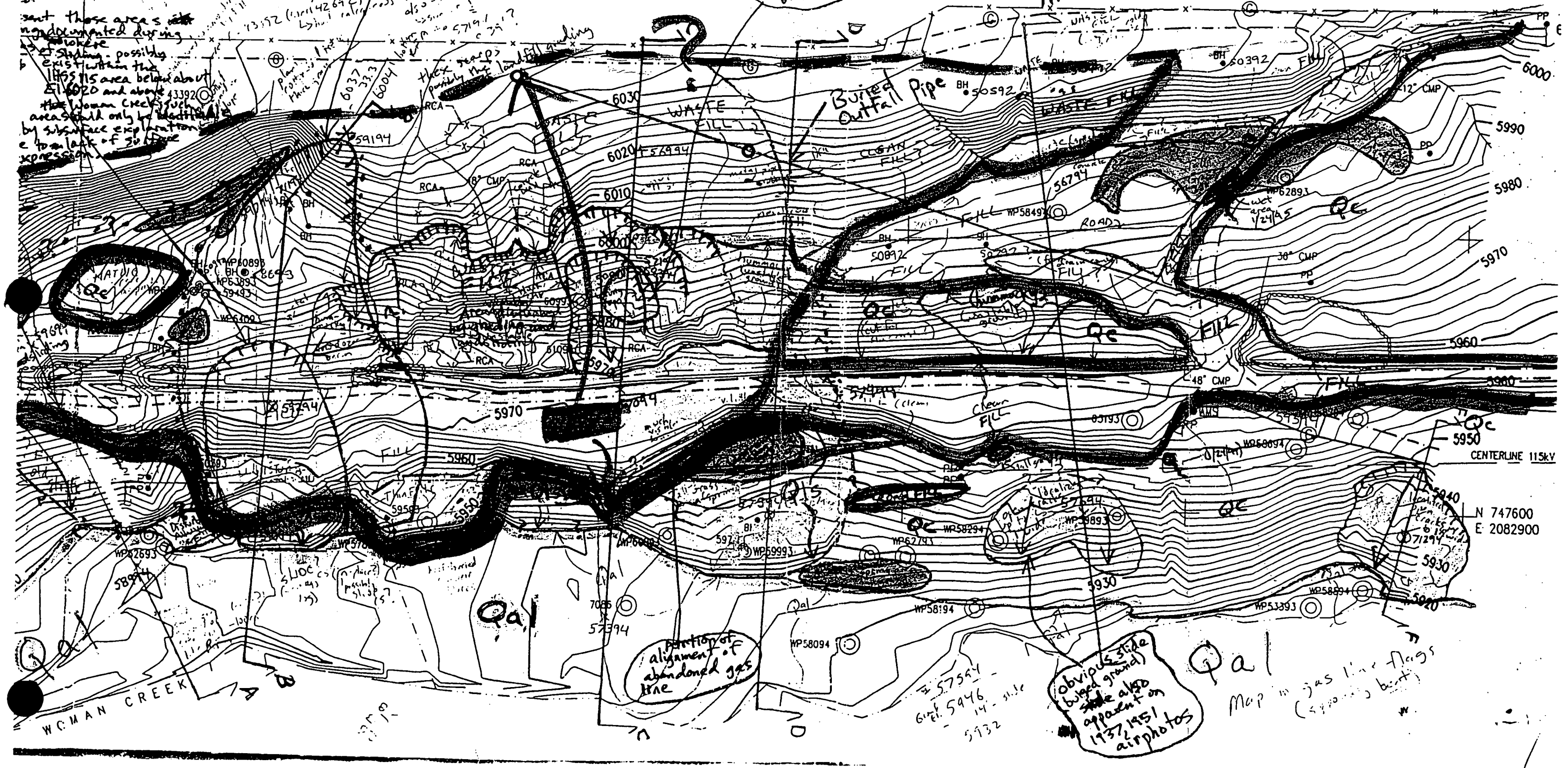
approx. location of
apparent landslide,
1937, 1951 airphotos

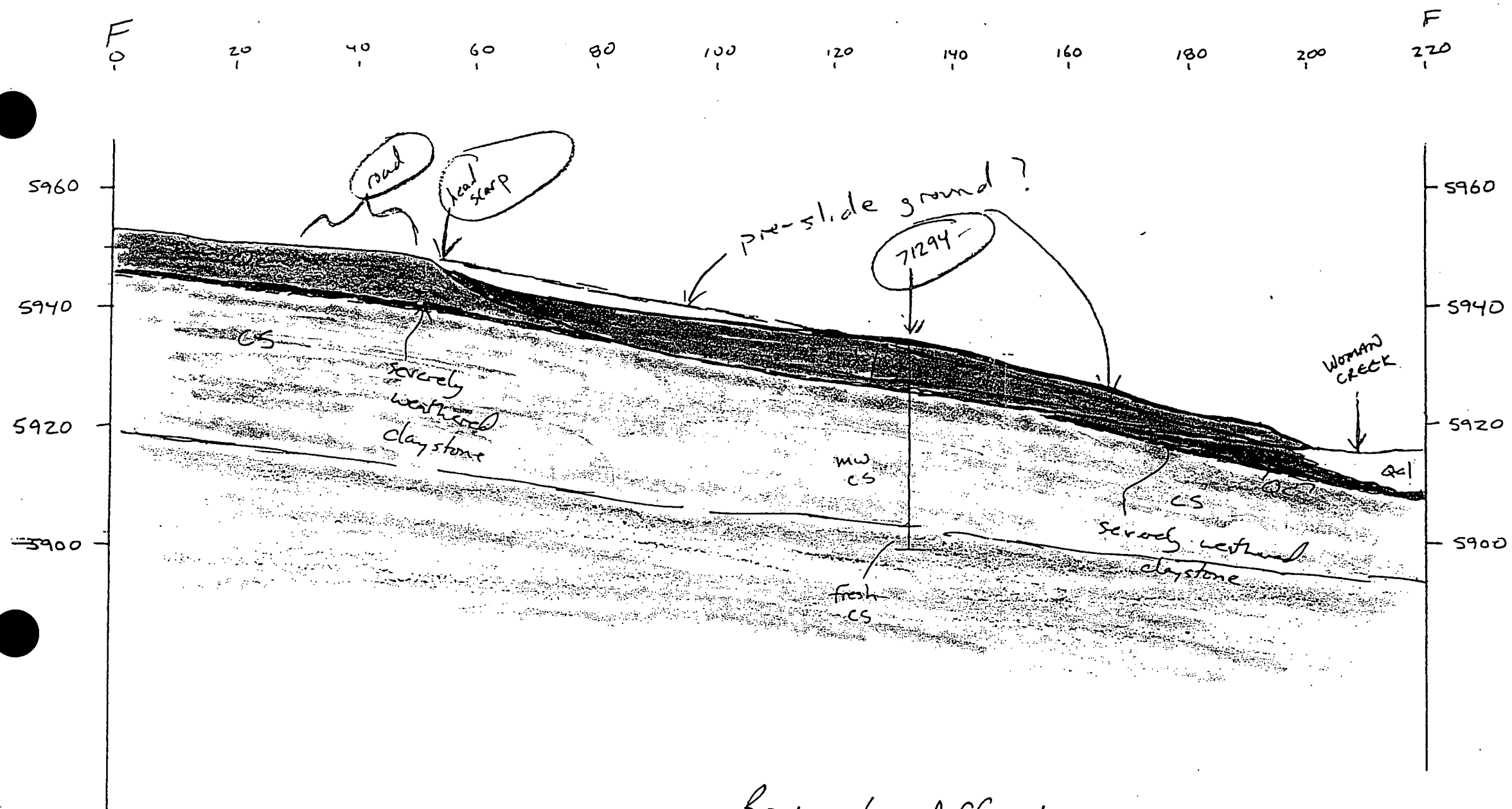
N 748200
E 2081400
mits are

N 748200
E 2082900

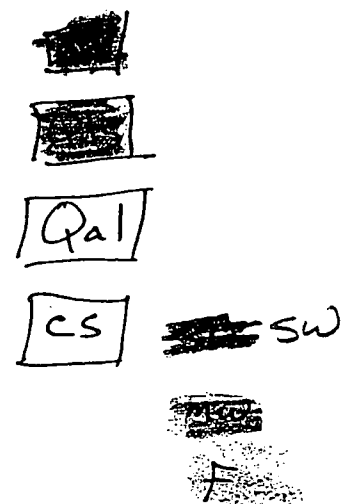
sent these areas
undocumented during
1951
existing - possibly
existing within the
1951 area below about
516020 and about 433920
the Woman Creek
area could only be identified
by subsurface exploration
e to lack of surface
expression

TTTT - steep (probable slides are
indicated by steep w/area
other steep may be result of
grading in landfill area)

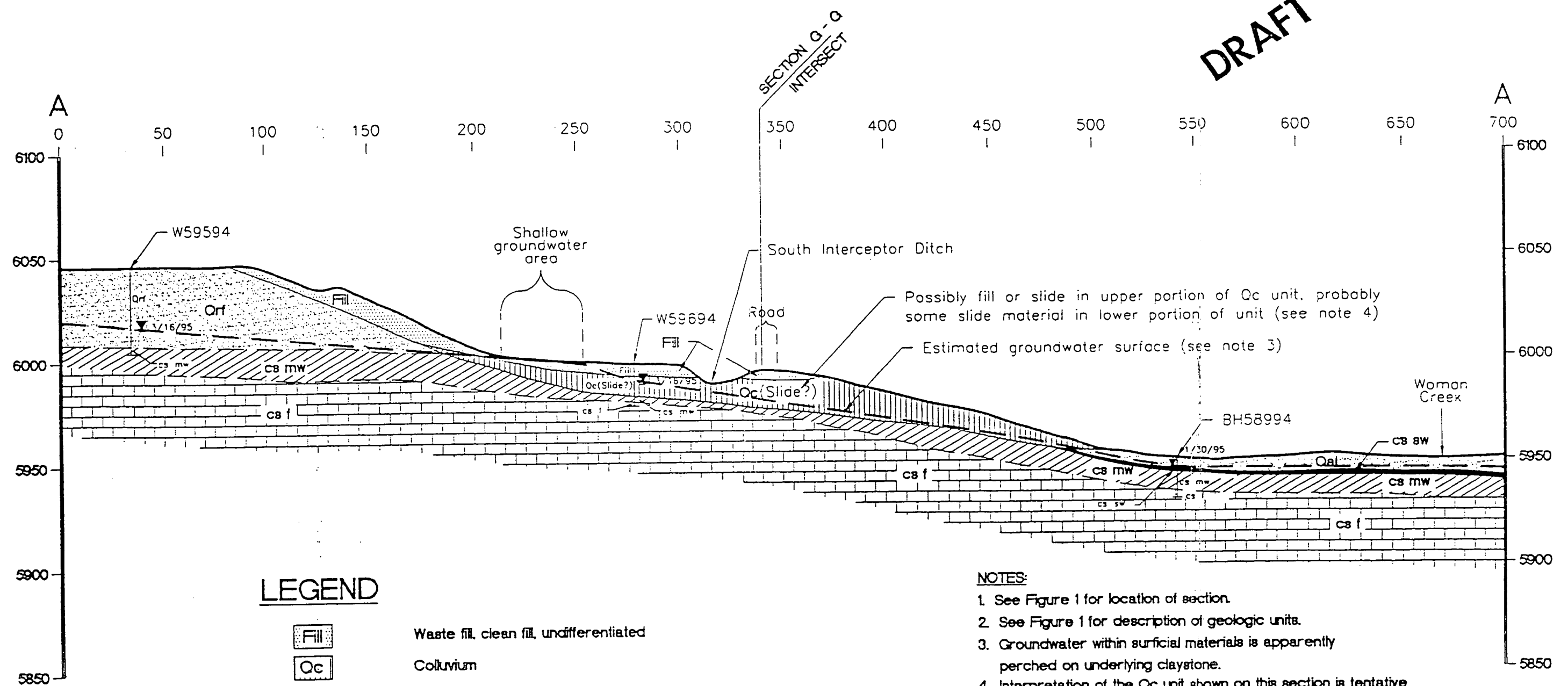




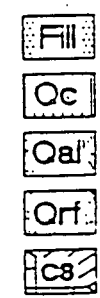
Ron: note different scale (1"=20')



DRAFT



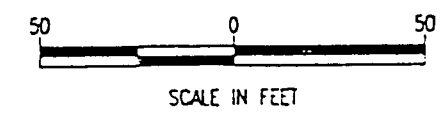
LEGEND



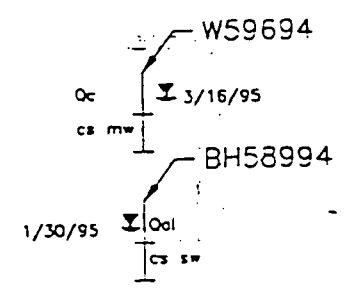
Fill Waste fill, clean fill, undifferentiated
Qc Colluvium
Qal Valley Fill Alluvium
Qrr Rocky Flats Alluvium
cs Laramie Formation Claystone:
sw - severely weathered
mw - moderately weathered
f - fresh

NOTES:

1. See Figure 1 for location of section.
2. See Figure 1 for description of geologic units.
3. Groundwater within surficial materials is apparently perched on underlying claystone.
4. Interpretation of the Qc unit shown on this section is tentative and based on materials encountered in W59694: the location of pre-landfill ground surface along this section is needed to more confidently interpret origin of these materials.



PRELIMINARY

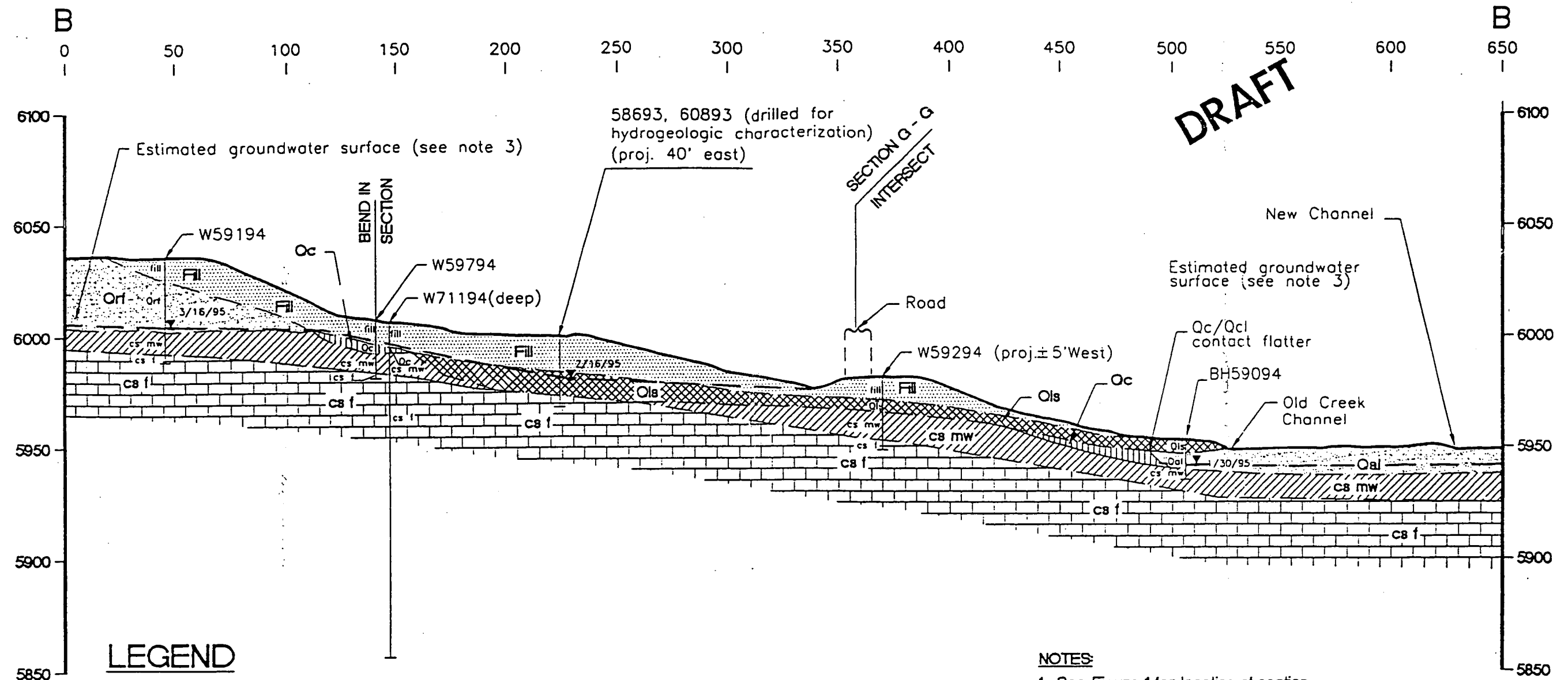


Geotechnical boring with monitoring well showing geologic units, groundwater elevation and date measured.
Geotechnical boring, backfilled, showing geologic units, groundwater elevation, and date encountered.

PROJECT #:	32242
ORIG. DATE:	MAY, 1995
PREP. BY:	R. RIDENOUR
REV. BY:	R. HARLAN
SCALE:	1" = 50'
FILE NAME:	N:\...ROCKY\A.DWG

RUST ENVIRONMENT & INFRASTRUCTURE
San Jose, CA

SECTION A-A
ROCKY FLATS ENVIRONMENTAL
TECHNOLOGY SITE OU-5
GEOTECHNICAL INVESTIGATION



LEGEND



Waste fill, clean fill, undifferentiated



Colluvium



Landslide Deposits (unit may contain material from several discrete landslides).



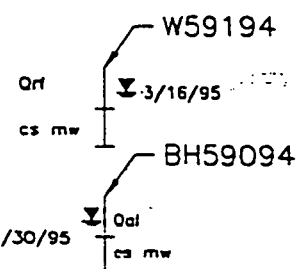
Valley Fill Alluvium



Rocky Flats Alluvium



Laramie Formation Claystone: sw = severely weathered
mw = moderately weathered
f = fresh

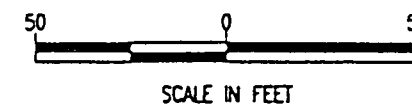


Geotechnical boring, with monitoring well, showing geologic units, groundwater elevation and date measured.

Geotechnical boring, backfilled, showing geologic units, groundwater elevation, and date encountered

NOTES

1. See Figure 1 for location of section.
2. See Figure 1 for description of geologic units.
3. Groundwater within surficial materials is apparently perched on underlying claystone.
4. Interpretation of the Qc unit shown on this section is tentative and based on materials encountered in W59694; the location of pre-landfill ground surface along this section is needed to more confidently interpret origin of these materials.



PRELIMINARY

PROJECT #:	32242
ORIG. DATE:	MAY, 1995
PREP. BY:	R. RIDENOUR
REV. BY:	R. HARLAN
SCALE:	1" = 50'
FILE NAME:	N:\...ROCKY\AADWG

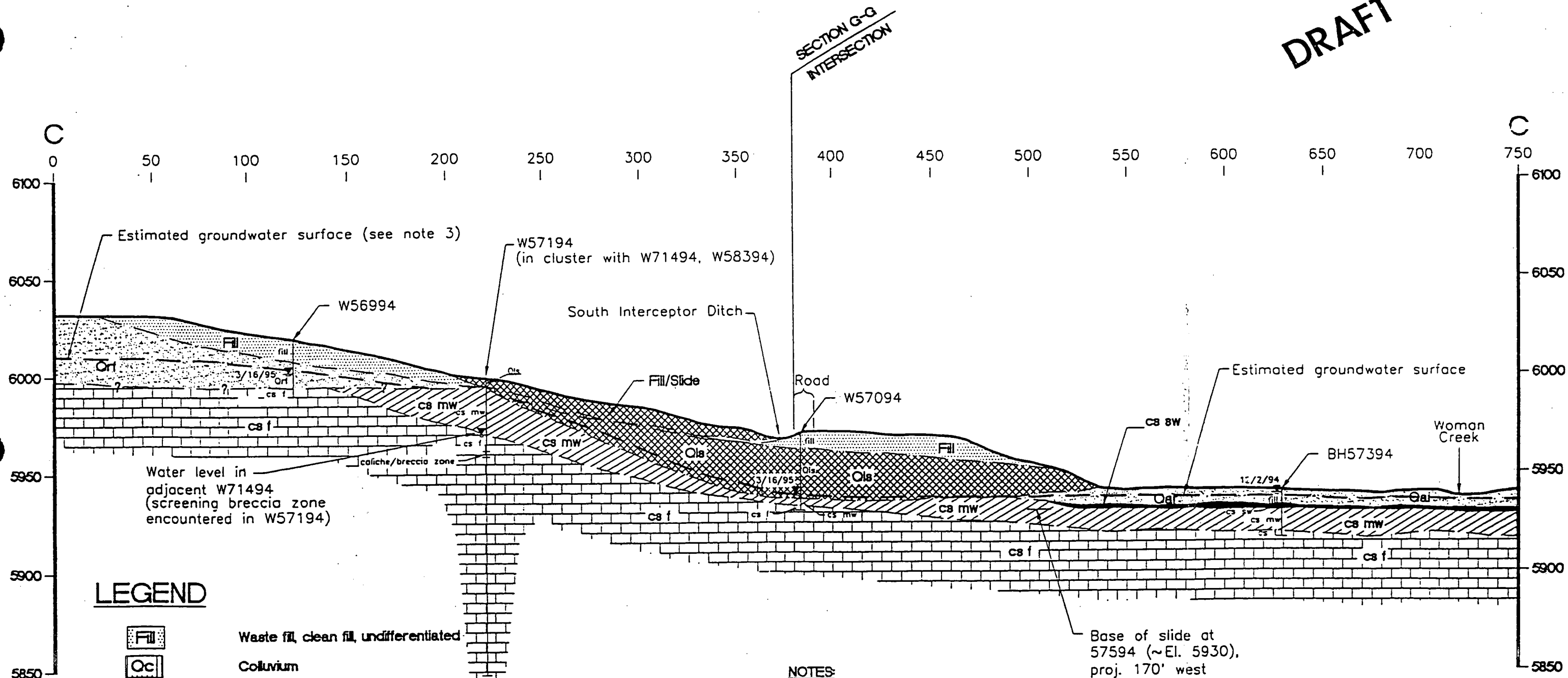
RUST ENVIRONMENT &
INFRASTRUCTURE
San Jose CA

SECTION B-B
ROCKY FLATS ENVIRONMENTAL
TECHNOLOGY SITE OU-5
GEOTECHNICAL INVESTIGATION

FIGURE

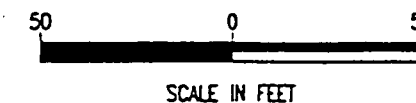
3

DRAFT



NOTES

- See Figure 1 for location of section.
- See Figure 1 for description of geologic units.
- Groundwater within surficial materials is apparently perched on underlying claystone.
- Interpretation of the Oc unit shown on this section is tentative and based on materials encountered in W59694; the location of pre-landfill ground surface along this section is needed to more confidently interpret origin of these materials.



PRELIMINARY

PROJECT #: 32242
 ORIG. DATE: MAY, 1995
 PREP. BY: R. RIDENOUR
 REV. BY: R. HARLAN
 SCALE: 1" = 50'
 FILE NAME: N:\...ROCKY\CC.DWG

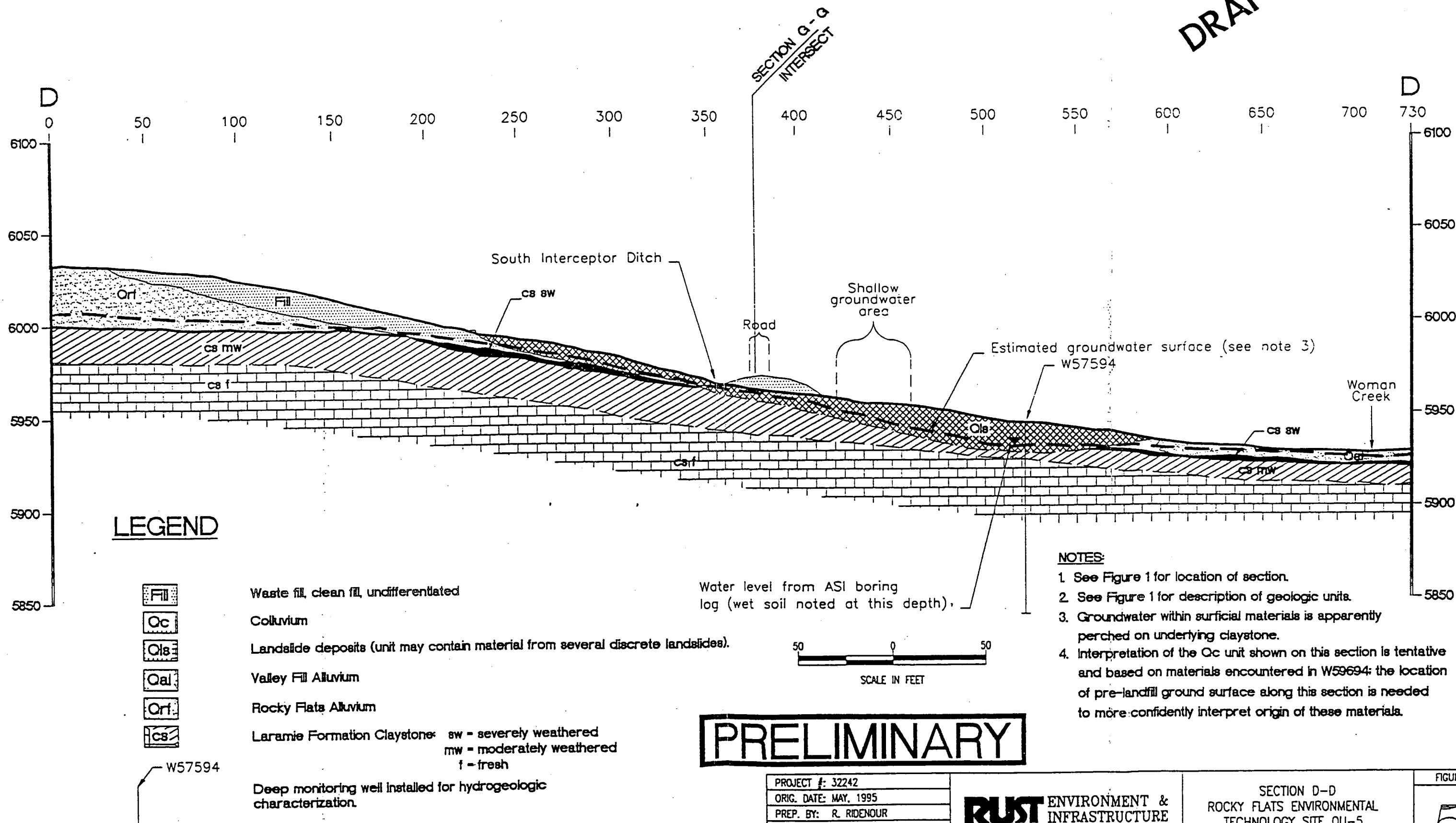
RUST ENVIRONMENT & INFRASTRUCTURE
 San Jose, CA

SECTION C-C
 ROCKY FLATS ENVIRONMENTAL
 TECHNOLOGY SITE OU-5
 GEOTECHNICAL INVESTIGATION

FIGURE

4

DRAFT



PROJECT #: 32242
 ORIG. DATE: MAY, 1995
 PREP. BY: R. RIDENOUR
 REV. BY: R. HARLAN
 SCALE: 1" = 50'
 FILE NAME: N:\...ROCKY\DD.DWG

RUST ENVIRONMENT & INFRASTRUCTURE
 San Jose, CA

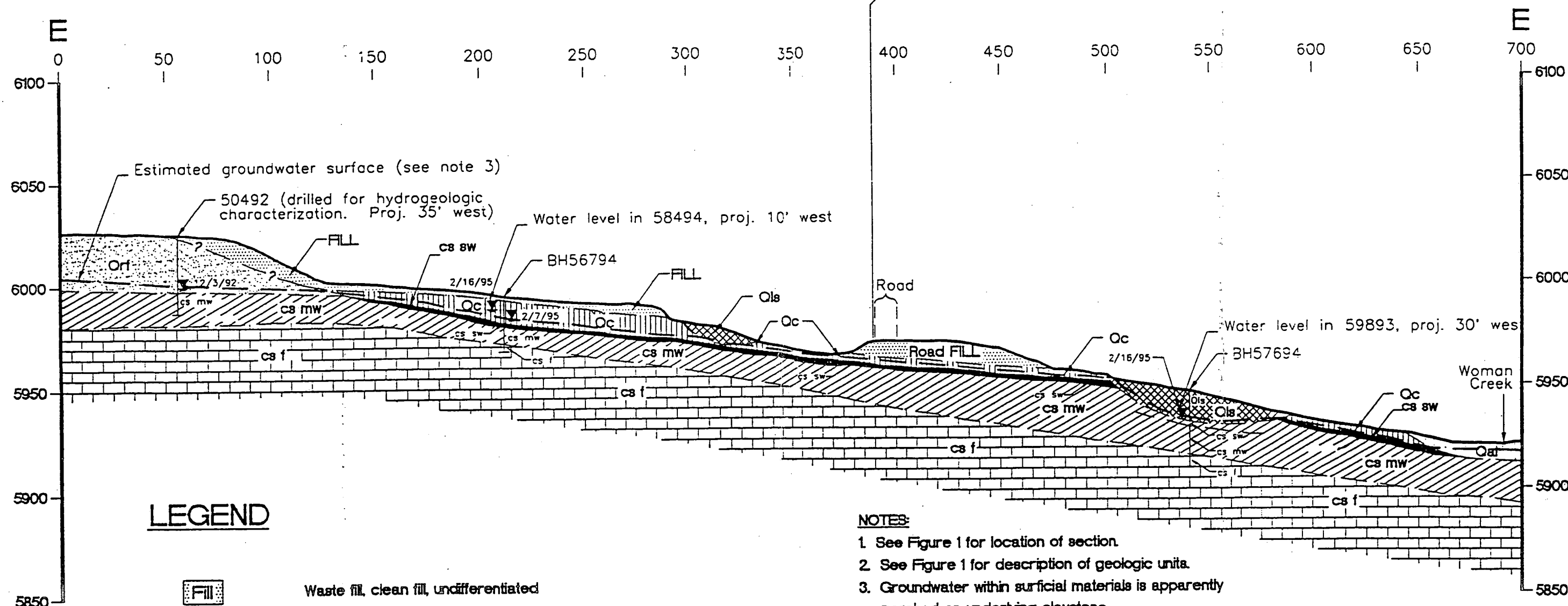
SECTION D-D
 ROCKY FLATS ENVIRONMENTAL
 TECHNOLOGY SITE OU-5
 GEOTECHNICAL INVESTIGATION

FIGURE

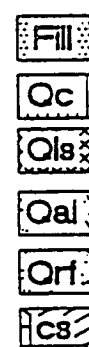
5

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SECTION G-G
INTERSECT



LEGEND



- Waste fill, clean fill, undifferentiated
- Colluvium
- Landslide Deposits (unit may contain material from several discrete landslides)
- Valley Fill Alluvium
- Rocky Flats Alluvium
- Laramie Formation Claystone:
 - sw = severely weathered
 - mw = moderately weathered
 - f = fresh

BH57694
3/16/95

Geotechnical boring, backfilled, showing geologic units, groundwater elevation, and date encountered.

NOTES:

- See Figure 1 for location of section.
- See Figure 1 for description of geologic units.
- Groundwater within surficial materials is apparently perched on underlying claystone.
- Interpretation of the Qc unit shown on this section is tentative and based on materials encountered in W59694; the location of pre-landfill ground surface along this section is needed to more confidently interpret origin of these materials.

50 0 50
SCALE IN FEET

PRELIMINARY

PROJECT #: 32242
ORIG. DATE: MAY, 1995
PREP. BY: R. RIDENOUR
REV. BY: R. HARLAN
SCALE: 1" = 50'
FILE NAME: N:\...ROCKY\EE.DWG

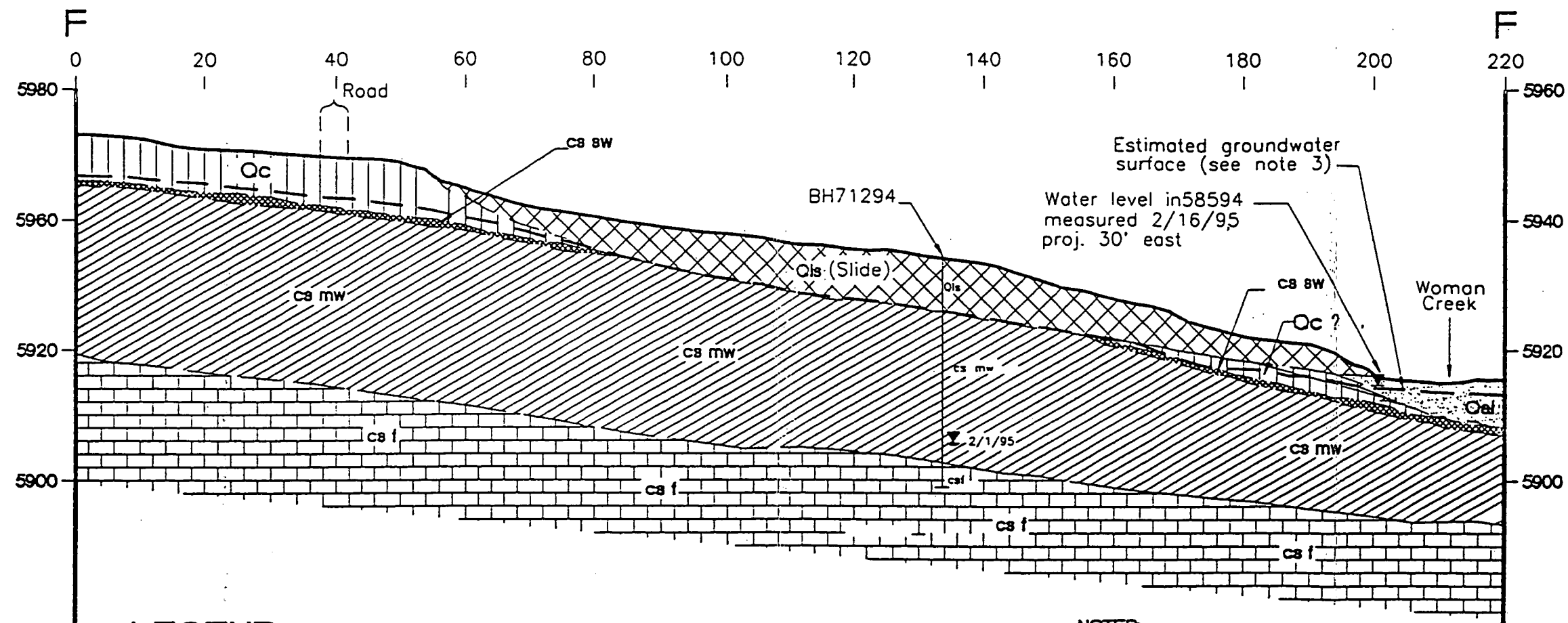
RUST ENVIRONMENT & INFRASTRUCTURE
San Jose, CA

SECTION E-E
ROCKY FLATS ENVIRONMENTAL
TECHNOLOGY SITE OU-5
GEOTECHNICAL INVESTIGATION

FIGURE

6

DRAFT

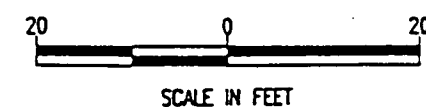


LEGEND

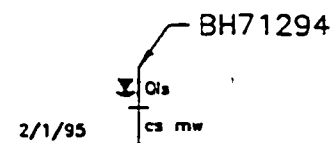
- Waste fill, clean fill, undifferentiated
- Colluvium
- Landslide Deposits (unit may contain material from several discrete landslides)
- Valley Fill Alluvium
- Rocky Flats Alluvium
- Claystone: sw - severely weathered
mw - moderately weathered
f - fresh

NOTES:

1. See Figure 1 for location of section.
2. See Figure 1 for description of geologic units.
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PRELIMINARY



Geotechnical boring, backfilled, showing geologic units, groundwater elevation, and date encountered.

PROJECT #:	32242
ORIG. DATE:	MAY, 1995
PREP. BY:	R. RIDENOUR
REV. BY:	R. HARLAN
SCALE:	1" = 20'
FILE NAME:	N:\...ROCKY\FF.DWG

RUST ENVIRONMENT & INFRASTRUCTURE
San Jose, CA

SECTION F-F
ROCKY FLATS ENVIRONMENTAL
TECHNOLOGY SITE OU-5
GEOTECHNICAL INVESTIGATION

FIGURE
7